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ETHNOBIOTICA

Darrell Addison Posey

1947-2001

Darrell Posey, 53, who had a celebrated career as ethnobiologist, anthropologist, activist, and specialist on Amazonia, died at Oxford, England on March 6th, 2001 from inoperable brain tumors that had been diagnosed a few months before. Posey probably will be most remembered for his research on Kayapó Indian resource management and environmental knowledge together with his notable activism in defending the Kayapó and other peoples against the Xingu Hydroelectric Project of the late 1980s. On both academic and political fronts, Posey received strong support from many loyal colleagues and friends as well as fierce opposition from assorted detractors and enemies. A charismatic figure, Posey seemed to thrive at the center of controversy. It must be that his personal drive and many friendships weighed more heavily in the end than the ardor and dedication of his adversaries and his disappointments in life. Other than his academic contribution to ethnobiology, Posey had attended the second meeting of the Society of Ethnobiology as well as many meetings after that and was a member of the Editorial Board of the Journal of Ethnobiology since the founding of the journal with volume 1, number 1 in May 1981 until his death.

Born and raised in Henderson County, Kentucky, Posey never lost the midland accent characteristic of that region. He earned the B.S. in entomology at Louisiana State University in 1970, the M.A. in geography and anthropology at Louisiana State University in 1974, and the Ph.D. in anthropology at the University of Georgia in 1979. Posey was an interdisciplinary scholar long before the explosion of interdisciplinary programs in universities and research institutes in the 1980s and 1990s. He was also a prolific writer. In terms of his published output to date, Posey authored or co-authored three books, edited or co-edited four books, wrote 154 articles and chapters, and produced 22 book reviews, some of which were reprinted in one form or another. He directed two museum exhibits on Kayapó resource management and compiled the catalogues that accompanied them. He was also involved in the production of fifteen documentary films and videos, mainly on Kayapó ethnobiology and resource management. At the time of his death, Posey had two authored books and three edited books in press.

Among the numerous awards Posey received for his work and activism were the "Chico Mendes Award" for Extraordinary Courage in the Defense of Nature, given by the International Sierra Club in 1989 and the United Nations "Global 500 Award" for Outstanding Achievement in Service to the Environment, bestowed on him by the U.N. Environmental Programme in 1993. At the time of his death, he was coordinator of ECOS (Ethnoecology: The Ecological and Social Dimensions of Well-Being) at the Institute for Social and Cultural Anthropology of the University of Oxford. He also held other positions at Mansfield College, Oxford and the Federal University of Maranhão, Brazil. He was elected Fellow of the prestigious Linnean Society of London in 1999 and he maintained professional affiliations with Linacre College (Oxford), St. Anthony's College (Oxford), the Institute of Ethnobiology of the Amazon (which he had founded at Belém, Brazil), and the Carnegie Museum of Natural History. He held numerous advisory and editorial positions with various organizations, including the Society of Ethnobiology, the International Society of Ethnobiology, the Global Environment Facility, and the Indigenous Peoples Media Center.

Posey rather single-handedly founded the ethnobiological study of Amazonia and its peoples. Already well-known as an original researcher on Kayapó folk entomology (among other findings, his research in this area showed that the Kayapó recognized more species of wasps than Western taxonomy in regard to the Kayapó area, and that, indeed, one of the

species so recognized was new to science) and native resource management, having published his research in numerous peer-reviewed journals, Posey in 1988 found himself at the center of a professional and political crisis that would catapult him eventually to global renown. In 1987, while serving as Director of the Ethnobiology Program at the Museu Paraense Emílio Goeldi in Belém, Brazil, he was asked by the then Director of that museum, Dr. Guilherme de La Penha, to undertake an environmental and social impact study of indigenous populations in the area of influence of the Xingu Hydroelectric Project, with funding for the study to be provided by Eletronorte, a state-run electrical power company. Posey later said he believed he could mitigate the effects on native peoples of the dam project, then in the late stages of planning, by working against it from the inside. The dam project itself, once completed on the lower Xingu River, would flood a large area of indigenous lands and reserves, including part of the lands pertaining to the Kayapó of the village of Gorotire, which is where Posey had carried out most of his ethnobiological research since the time of his dissertation fieldwork and where he had many friends. By early 1988, Posey realized that his work from within would come to naught; he called it an "aborted effort." Later that year, he traveled with two Kayapó Indian leaders to Washington, D.C. in order to denounce the dam project in the offices of the President of the World Bank, who was then intending to disburse half a billion dollars in loans to Brazil in order to finance that project. As a result of this visit, and of the negative publicity that attended it, the World Bank soon suspended payment of the funds needed to drive the dam project forward. (In spite of Posey's efforts, the dam project has never been removed from national energy plans in Brazil).

Upon his return to Brazil, Posey and the two Kayapó leaders were arrested and fingerprinted on charges of harming the reputation abroad of Brazil. Soon released and awaiting trial on the charges, and also warned by the United States Embassy in Brasília that his life was now in danger, Posey continued with plans to host the First International Congress of Ethnobiology, which was held in July, 1988, at Belém, Brazil. The congress included hundreds of scholars from thirty-five countries and proved to be a resounding success, in spite of the presence of undercover federal intelligence agents, who mingled with the crowd. The Declaration of Belém, which called for protection of native knowledge, use, and management of biological resources as well as human rights of native peoples, was one of the results of this congress, largely thanks to Posey's efforts. While Posey was enjoying widespread endorsement for his activism by many colleagues in the international arena, the charges against him and the two Kayapó leaders were quietly dropped.

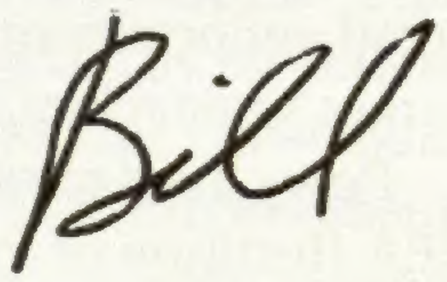
Posey lived mostly in Germany during 1989-91 as a Humboldt Fellow; he also founded INEA (Institute of Ethnobiology of the Amazon), an NGO headquartered in Belém. He eventually vacated his research position at the Museu Goeldi and became Senior Associate Fellow at Oxford in 1992, where he remained in one capacity or another until his death. Having confronted the Brazilian federal machinery over the Xingu Hydroelectric Project in 1988 (and it must be said in fairness that some of Posey's supporters were Brazilian federal and state officials who themselves shared sympathy for his cause), Posey became Special Advisor to the Brazilian Special Secretary on Internal Affairs and Indigenous Peoples during 1992. In that same year, he was Convenor and President of the Earth Parliament at the Earth Summit in Rio de Janeiro.

From about that time on, Posey's work was primarily aimed at promoting the intellectual property rights (IPR) of native peoples while simultaneously opposing the threats to these rights that he perceived to be emanating from international pharmaceutical and other commercial interests. In 1992, Eugene Parker, who had been one of Posey's collaborators, published a scathing review of Posey's work with the Kayapó, calling into question, in

particular, Posey's findings with regard to Kayapó management and fostering of the forest islands that dot their otherwise well-drained, savanna landscape. Posey had claimed in various publications that these forest islands were basically anthropogenic. Parker argued, essentially, that the forest islands were naturally occurring phenomena and that Posey's methods in determining them to be otherwise were flawed and sloppy. The debate over the validity of Posey's data was reminiscent of the Redfield/Lewis and Mead/Freeman controversies from earlier generations of anthropology. Posey replied in the *American Anthropologist* that since Parker did not conduct his interviews in the Kayapó language, he would not have found evidence necessary to negate Posey's conclusions about the efficacy of native knowledge in remaking the landscape under question. Parker then supplied a rejoinder in the same journal, reiterating what he had asserted to be questionable science on Posey's part. Posey responded, in his defense, one more time to this critique in a chapter published in W. Balée (ed.), *Advances in Historical Ecology* (1998). It seems likely that this controversy between Parker and Posey will remain unsettled until further, scientifically sound archaeological and ethnolinguistic research is carried out to determine the origins and development of forest islands in the *cerrado* country of the Gorotire Kayapó.

Regardless of this inflammatory exchange in the pages of the *American Anthropologist*, Posey by 1992 was devoting much more of his time to IPR. Indeed, he published three major books on that subject in 1996 (D.A. Posey and G. Dutfield, *Beyond Intellectual Property*; D.A. Posey, *Traditional Resource Rights*; and D.A. Posey and G. Dutfield, *Indigenous Peoples and Sustainability*), all of which were favorably reviewed. At the very end of his life, Posey's unpublished work reflected a return to his original research on the Kayapó and in ethnobiology. The two books authored by Posey and still in press at the time of his death are entitled *Ethnobiology of the Kayapó Indians of Brazil* and *Ethnobiology: Principles and Practices*.

A full account of Darrell Posey and the influence he exercised on ethnobiology, Kayapó studies, native resource management, and activism for native land rights and IPR remains to be written. For those who knew him in life, Darrell Posey will be remembered for his courage in the face of danger; his loyalty as a friend and colleague; his charismatic effect on researchers, young and old, around the globe; and his folksy, Kentucky wit and humor that never seemed to fail him, even in his darkest trials. He will be missed.



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MAYA KNOWLEDGE AND "SCIENCE WARS"

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ABSTRACT.—Knowledge is socially constructed, yet humans succeed in knowing a great deal about their environments. Recent debates over the nature of "science" involve extreme positions, from claims that all science is arbitrary to claims that science is somehow a privileged body of truth. Something may be learned by considering the biological knowledge of a very different culture with a long record of high civilization. Yucatec Maya ethnobiology agrees with contemporary international biological science in many respects, almost all of them highly specific, pragmatic and observational. It differs in many other respects, most of them highly inferential and cosmological. One may tentatively conclude that common observation of everyday matters is more directly affected by interaction with the nonhuman environment than is abstract deductive reasoning, but that social factors operate at all levels.

Key words: Yucatec Maya, ethnoornithology, science wars, philosophy of science, Yucatan Peninsula

RESUMEN.—El El conocimiento es una construcción social, pero los humanos pueden aprender mucho ce sus alrededores. Discursos recientes sobre "ciencia" incluyen posiciones extremos; algunos proponen que "ciencia" es arbitrario, otros proponen que "ciencia" es verdad absoluto. Sería posible conocer mucho si investiguemos el conocimiento biológico de una cultura, muy diferente, con una historia larga de alta civilización. El conocimiento etnobiológico de los Yucatecos conforme, más o menos, con la sciencia contemporánea internacional, especialmente en detallas derivadas de la experiencia pragmática. Pero, el es deferente en otros respectos—los que derivan de cosmovisión o de inferencia logical. Se puede concluir tentativamente que la observación de fenómenos concretas es más afectada por la interacción con el medio ambiente que por el razón deductivo, pero que factores sociales influyen el pensamiento en todos niveles.

RÉSUMÉ. –La connaissance est construée socialement, mais, aussi, les hommes apprendrent beaucoup de leurs environs. En les debâts reciens sous la nature de "science" il y a positions extrèmes. Les uns propose que "science" est des chose arbitraires; les autres propose que "science" est la vérité absolue. C'est possible à savoir plus de ces choses, en considerant la connaissance biologique d'un culture different—un culture que tient une "longue durée" civilisée. Les Maya yucateque possèdent un système biologique que ressemble à celui de la science contemporaine. La plupart des ressemblances existent en domaines d'observation pragmatique et quotidienne. Les differences (ou, selon Derrida, "differances") sont des choses logicales ou cosmologiques. On peut concluir, tentativement, que la observation de phenomènes concrètes est plus afectée par l'interaction avec l'environment que le raison logical, mais les influences sociales existent en touts niveaux.

SCIENCE WARS

Anthropology has recently seen debates concerning the nature and value of "science." These debates are part of a wider challenge to canons of truth, of literary quality, and indeed of all those matters that anthropologists regard as part of culture.

As is frequent in academic conflicts, the debate over "science" has quickly escalated, with the most famous participants being those who take the most extreme positions. This has led to the term "science wars" (see the excellent account in Hacking 1999). However, there are serious questions under the rhetoric. Leading philosophers of science disagree profoundly—though, of course, less profoundly than the extremists of the semi-popular media—over the nature and practice of science.

It is obviously impossible to summarize this debate here, even at a superficial level; the present article merely makes a small contribution to the knowledge base that underlies one aspect of the controversy, the debate on how much of science—in this article, more specifically the classification of living things—is social construction, and how much is based on a reality out there in the world.

Loosely arrayed on one side are those such as Imre Lakatos (1976), Thomas Kuhn (1962), Ian Hacking (1999), and Paul Feyerabend (1987), who hold various positions that give social construction a large role in scientific practice. They are not a uniform group. Kuhn sees the social organization of science as structuring the quest for truth, but is not ready to write off either the search or the goal as hopeless. (In spite of certain claims to the contrary, Kuhn clearly states that he regards some paradigms as more correct than others, and he sees progress in science over time.) Hacking, also, explicitly distances himself from those who see "science" as the construction of arbitrary nonsense, though he sees social construction as important and sometimes overriding the truth. Feyerabend seems to hold a more radical position, at least for debating purposes; he appears to see science as a social belief system, no more believable on the face of it than witchcraft or flying-saucer lore.

There are those who think—following Foucault (e.g. 1971) but going far beyond anything Foucault actually said—that, since we cannot know external truth, all of the claims of science must be false, and must be made simply to keep elites in power, as "truth" was constructed in Orwell's *1984* (Orwell 1948). This is the "vulgar Marxist" version of Marx' claims about religion, expanded to cover the field that many people see as the "new religion" of "20th century" people (on these matters see Hacking 1999).

This position depends on an inconsistency: people are seen to be living in a completely solipsistic world in relation to the natural environment, yet to have a perfect grasp of the realities of interpersonal power. Thus, this position, like other radically "culturological" and culture-essentializing positions in anthropology, is deeply incoherent. People are hypothesized to have a mystical, virtually perfect grasp of their culture, such that insiders participate in a perfect unity that is unfathomable to outsiders—yet somehow this perfect learning does not extend to any phenomena other than social or cultural ones, and somehow the visiting ethnographer has no way of contacting that mystic participation. The natural world,

in particular, is apprehended only via this mystically absorbed cultural perception. The individual humans who are so superbly good at learning from their elders are incapable of learning from their observations.

Arrayed on the other side are a number of philosophers who see science as a way of getting at real truth about the environment—an enterprise that can be subverted or mistaken, but, when done right, gives us pragmatically consistent and useful data. Leaders of this general view include Philip Kitcher (1985, 1993), Larry Laudan (1996), Alexander Rosenberg (1992), Lewis Wolpert (1993), and many more. These too are a diverse lot, but they all agree that science is a search that produces ever more accurate data and theories, not just a social game that produces ever more complex arbitrary representations.

However, and notably, all these writers have abandoned the naïve positivist positions so popular in the early 20th century. No current philosopher of science (so far as I am aware) continues to defend the near-religious regard for "covering laws," "falsification," and "objectivity" that dominated science, and confined it in narrow channels, through much of the midcentury. Ian Hacking and Philip Kitcher provide especially sober and thoughtful critiques of this position (rather unfairly blamed on Karl Popper, who advocated such procedures but was not so naïve as to think they defined all science; see Hacking 1999; Laudan 1996).

It may be remembered that Francis Bacon, in his original definitions of the scientific enterprise, was not only aware of all these problems but was more sensitive to them than are some modern philosophers. He defined the observation-experiment method and warned his readers of the "Four Idols"—the biases we would now call "social construction" or "cultural baggage"—that can blind the unwary and unaware (Bacon 1901, orig. 16th cent.).

As noted above, Hacking, in the most recent salvo in the long and confusing "science wars," concludes that science is somewhat socially constructed, somewhat factual (1999:99). This seems to me to be rather an evasion.

The present paper obviously cannot even begin to summarize the literature on science wars." It merely makes a single point: science is 100% socially constructed, but usually an accurate representation of the world in spite of that. Evidence is supplied from a comparison of Maya and biological classifications of birds. Maya ornithological taxonomy maps fairly well onto biological taxonomy, but there are major differences. This disproves both simple realism (the Maya see the natural distinctions just as the biologists do) and extreme social constructionism (the Maya system must be totally different from the biologists', since the societies are so different).

What has been missed, in the "science wars," is the fact that society does not necessarily get things wrong. To say something is socially constructed is not to say it is inaccurate. After all, people have to learn their social constructions from each other. If they can learn their culture through interaction, why can they (and, thus, their culture) not learn about the environment from interaction, and then teach each other in further interpersonal interactions?

Anthropologists have turned their ethnographic gazes onto the actual practice of science in dozens of societies. Beginning with traditional small-scale societies, they have expanded their gaze to encompass modern laboratories. Particularly noteworthy for its impact on the intellectual field is the work of Laura Nader and

her associates (Nader 1996). Nader has long encouraged research on the movers and shapers of contemporary society, including scientists. Her group has thus studied modern laboratories and university halls, often comparing them with her alternative study area, the highland Zapotec world, which has its own science (Gonzalez 1998; Nader 1996).

Roberto Gonzalez, in particular, has provided some very thoughtful insights into Zapotec traditional agricultural science. He sees it as definitely a science (taking "science" in sense #1, below). He analyzes it in terms of "assumptions"—folk theories—that hold together a body of empirical, pragmatic knowledge. He shows that these work like the theories of modern international science: they are basic, largely counterintuitive ideas, extracted from experience, and used to generate new practices and to explain and justify old ones. Some of them are highly questionable, but so are some assumptions of modern science.

Serious studies of nonwestern science go back to the dawn of anthropology. One recalls Frank Cushing's researches on Zuni agriculture and food, not published in book form until 1920 (Cushing 1920) but carried out in the early 1870s. Malinowski also produced classic studies in this area (Malinowski 1935), as did his students such as Raymond Firth (1957) and Audrey Richards (1948). A self-conscious movement to study "ethnoscience" arose in the late 1940s, largely among students of George Murdock at Yale, working in Oceania (Goodenough 1953; Conklin 1962; Frake 1980). Many of the earlier ethnoscience studies seem to the contemporary anthropologist rather naively positivistic and formalistic, paying rather little attention to such ideas as did not fit well into a "Western" scientific framework. Ironically, this was *not* true of Cushing's (or, to a somewhat lesser extent, Malinowski's) work, which should have served as examples.

Closer to the area of this paper, Scott Atran (1999) has analyzed Itzá Maya "folkbiology" from a similar point of view, analyzing knowledge and its linguistic recognition.

In any case, this large body of research established "ethnoscience" or "folk science" as something to study. Ethnographers came to see traditional knowledge as worthy of serious, detailed attention. They were exhorted to understand it in its own terms ("emically"), rather than merely comparing it (usually unfavorably) with "Western" science. In spite of rearguard action by opposing scholars like Marvin Harris (1968), studies of traditional knowledge grew and flourished apace. It seems only natural—in fact, surprisingly long in coming—that ethnographers should turn their attention on contemporary university laboratories.

SCIENCE

This, of course, brings us up against the question of defining "science." Much recent writing conflates several different things under that label. The following seem to me to be quite separate phenomena:

1. Science as search for truth—for accurate data about the world, and for theories and hypotheses that model that world in ways that guide further searching and understanding. Wolpert (1993) notes that these latter are critical, and that science depends on fearlessly generating and testing even the most counter-

intuitive of proposals. It is understood that the search for truth often takes wrong turns, as in the famous cases of "phlogiston" (see Kuhn 1962) and static continents (Oreskes 1999), but that is in the nature of a search. The search is seen as resulting in a body of facts, or at least pragmatically useful data, held together by a framework of higher-level representations that can be called "theories" and "axioms," or, with Gonzalez (1998), "assumptions." To extreme social constructionists, this framework might be seen as merely "worldview" or "cosmovision."

2. Science as a repository of True Facts or of Absolute Truth. Although still militantly upheld by some champions (e.g. Sokal 1997), this position is no longer really tenable. Contemporary scientific practice can get us to the truth about many things when ordinary observation will not, but that does not make Science a God-given repository of infallible wisdom. In fact, philosophers of science now hold that a genuine search for truth *must* take wrong turns. Otherwise it is not a search—merely a repetition of the obvious. Humoral medicine, alchemy, phlogiston, and many other theories were good ideas in their time, probably the best that could have been done with the data at hand. The disproofs of these theories signalled advances in the methods and techniques of scientific practice, and, following those, the improvement of theory. Science advances not by learning *ex cathedra* truth but by providing better and better theories, as Kuhn (1962) pointed out and as most scientists now agree. Possibly a subvariant of the old science-as-God's-truth view is the popular conception of "science": Flashy technology. This is the concept we find in mass media and *Star Wars*. (Wolpert [1993] overmakes the distinction between science and technology, but has some valuable comments on the issue.)
3. Science as one specific form—the modern Western form—of the search for accurate knowledge. There are two major contenders for the form. First, there is the self-conscious "science" that began in perhaps the 14th century and was formulated in the 16th and 17th centuries in the writings and work of Francis Bacon, Galileo Galilei, René Descartes, and, later, men like Robert Boyle and Isaac Newton. This is a science defined (ultimately) as working from observation to inductive and then hypothetico-deductive theories, and testing these (and the observations also) by experiment. It contrasts this search with received wisdom, bias, and popular belief. This science did indeed break radically with earlier ways of knowing. If it is not the only "science," it at least deserves some sort of terminological marking; Randall Collins' "rapid discovery science" (Collins 1998) is a good choice. The second is "science" as defined by the logical positivists in the mid-20th century, with its formal operations, covering laws, emphasis on verification and/or falsification, and formally (=mathematically) stated theoretical models. (This is so restrictive that it has been abandoned by most current authorities.) This type of definition has the advantage of cutting off one specific type of truth-search, but it has the disadvantage of making comparison impossible between contemporary international science and other knowledge traditions.
4. Science as "what scientists do." This allows us to include the faked data, charlatanry, and vendettas that sometimes characterize scientific practice. It also

directs us to look at scientists as whole people—with their own eating habits, daily lives, paranoias, and so forth.

5. Science as a social institution. This, of course, does not exist in most traditional societies—even China, with its unquestionably great scientific tradition, did not have a concept of "science" or a "science establishment" (until modern times). Traditional societies usually have a term for "knowledge" but not one for "science" as opposed to other types of knowledge. Chinese *xue*, Arabic *'ilm*, and, of course, Greek/Latin *scientia* included philosophy, literary studies, history, and other humanities. By contrast, in the United States and other rich modern countries, "Big Science" now has a life of its own, institutionalized in such organizations as the National Science Foundation.

Evidently, the first three of these approaches characterize science as a special kind of truth-seeking activity. The second pair treat science as a part of social action in general—as a social construction. The third approach above is somewhat intermediate, in that it regards science as a social construction—but a superior one, one that inevitably leads to truer and better knowledge.

Champions of science see science as a truth-seeking activity, and see faked data, vendettas and the like as "bad science"—alien contamination of the enterprise. The attackers and critics of science see it as a part of social action, and thus see it in terms of 4 and 5 above. For many of them, the "bad science" is just as scientific as the "good," and phlogiston is just as real as any other scientific conclusion (presumably including well-demonstrated things like the laws of thermodynamics).

There are thoughtful reasons to see science in all the above ways—so long as they are kept analytically distinct.

If one looks at institutions, modern American "Big Science" is a totally different thing from the tiny and scattered band of experimenters, often working in terror of religious persecution, who created European "modern science" in the 1500s. They are linked by being related to the search for truth and understanding, but they are not linked by similarities in institutional or political forms.

Conversely, if one is looking at the accumulation of accurate data, one can reasonably look at Assyrian medicine, Chinese agricultural experiments, and Maya bird lore along with Nobel Prize experiments. One will not, however, be terribly concerned about the personal lives of the Assyrian or Chinese scholars.

If one sees science in a broader and more sociological sense—science as the activities of people who want to know something about the world, beyond what intuition and received wisdom tell them—then the personal lives of the Assyrian and Maya scholars become more interesting. This is the position of most historians of science. It has the major advantage of allowing all human societies into the club, rather than defining "science" so as to restrict it to one cultural tradition. Given the high prestige of the word "science" in today's world, there are obvious political ramifications to these alternate courses of action.

Certainly the most reasonable of the restrictive definitions would confine the term "science" to post-1600 Baconian-Galilean science. This would reduce to a historical footnote the Assyrians, Chinese, Mayas, and indeed well over 99% of the human species' long quest for understanding.[1] If "science" is limited to the

institutionalized rules of methodology that the positivists and scientific philosophers of the early 17th century (let alone the 20th century) invoked, then by definition there was no science before 1600 (or 1900 in the case of the positivists). Moreover, much of modern science does not count. Astronomy, astrophysics, paleontology, historical geology, most of ecology, and most of behavior biology are basically observational sciences, rather than being based on controlled experiments. Not only Maya bird lore, but even professional ornithological research, rarely conforms to the full Popperian or Hempelian canon (see Kitcher 1993 for the best discussion of these issues). Above all, and most directly relevant to the present paper, taxonomy is not a hypothesis-and-lab-experiment science, though modern cladistics is beginning to change that.

Much of the rhetoric in the "science wars" of the late 20th century has been associated with a disregard for the above distinctions. Sometimes the disregard appears to be willful, but often it is simply careless. In any case, what has often happened has been an all-out attack on the entire search for knowledge and understanding, justified by the failings of some scientists (some do fake their data, many are biased in one way or another). Conversely, some champions of science have failed to make the necessary distinctions, and have talked as if an attack on the current social institutionalization of science in the United States was an attack on all attempts to know anything. Sokal (1997), in particular, seems to be perilously close to taking such a view.

Of course, in the real world, it is impossible to have a search for truth that is completely disinterested, wholly objective, and uninfluenced by social attitudes and institutions. We have known this since at least the day of David Hume. Even after half a century of critical theory, C. Wright Mills' book *The Sociological Imagination* (1950) remains probably the best statement on the subject in social science. The best the scientist can hope for is to understand biases, adjust them in a moral direction, and compensate for them by seeking verification or disproof of findings from other investigators from other schools or laboratories (Bacon 1901; Kitcher 1993).

At this point, it may be interesting to turn to a different tradition. If two utterly different societies, with utterly different scientific traditions, come to similar conclusions from similar data, perhaps there is objective truth lurking behind the cultural screen. If and when two such societies differ totally in the way they construct the world, then science may not exist at all, and the social construction of knowledge may truly be said to be an arbitrary and solipsistic activity. To some extent, the degree of "social construction" in science is an empirical question.

THE MAYA OF QUINTANA ROO

For the last ten years, in collaboration with Mexican (including Maya) and United States colleagues, I have been carrying out research on knowledge of plants and animals among the Yucatec Maya of the "Maya Zone" of Quintana Roo. This, the central part of the state, is the area that was never truly reconquered after the Maya rebellion of 1846-48 known as the "Caste War" (Bricker 1981; Dumond 1998). The Maya in the present Yucatán state were crushed in 1848, but in what is now

Quintana Roo they remained independent until 1901, and in the remote west-central interior they were never really subdued. There was fighting as recently as 1934 in Dzula, the community next to my own base in Chunhuhub. Current inhabitants of Dzula do not admit defeat. Alfonso Villa Rojas, ethnographizing the area eastward in the mid-1930s, encountered much hostility and some personal danger. The Maya, unsubdued, have continued to preserve a cultural tradition that is at least five thousand years old in the area (Redfield & Villa Rojas 1934).

Like all cultures, Yucatec culture has profoundly changed over time, and is rapidly changing today; but Yucatec biological knowledge retains much knowledge of respectable antiquity. This is shown by archaeology, which discloses five millennia of milpa fields and cropping patterns not dissimilar to many one sees today (see Sharer 1994). It is also shown by colonial documents, which, from the 16th century onward (Landa 1937; Álvarez 1997; Arzápalo Marín 1987, 1996; analyses in Anderson and Medina in prep.), record biological and medical lore close to today's. The Maya, as everyone knows, created one of the greatest, most brilliant, most innovative, and most original civilizations the world has ever seen (Sharer 1994). The modern Yucatec of Quintana Roo are one of the several successor groups of the Classic Maya. It is probably safe to assume that much of their biological knowledge is derived from a Classic Maya base, given the consistency in usage since the very earliest dictionaries (Álvarez 1997; Anderson and Medina in prep.). This base has been greatly supplemented in more recent centuries by Spanish (including Moorish) lore and international biological science. The modern Maya are not some sort of living fossil, preserving for us the mysteries of the Classic Maya; nor are they a tiny isolated group. They are bearers of the elaborate and expert science of a long-lived, populous, brilliantly successful, constantly evolving civilization.

Maya languages have a written tradition going back 1600 years, at first in hieroglyphic and syllabic scripts, later in Spanish letters. Written transmission has been a small but significant part of cultural transmission for a very long time. In Yucatan, for instance, we have such examples as the Rituals of the Bacabs (orig. ca. 1600; see Roys 1965, Arzápalo Marín 1987), which records magical and medical lore from the earliest part of the Colonial period.

Such a huge tradition is far from homogeneous or uniform (see e.g. Hervik 1999), and has its own self-reflexive turn (Sullivan 1989). This article focuses on knowledge recorded in and around Chunhuhub, Quintana Roo.

Chunhuhub is a large farming town of some 5,000 people, occupying an *ejido* (communal landholding) of 14,330 ha. All are Yucatec Maya except for a few administrators and technicians, and a small number of in-migrants from central Mexico. Almost everyone is bilingual. Most families still raise maize, beans, squash, chilies, and other crops by slash-and-burn cultivation of tracts ranging from 1 to 4 ha. Yields reach a ton per hectare or more. Every family has its dooryard garden; many of these are large and contain up to 90 species of useful plants. Herbal medicine is commonly practiced. Some game is still obtained, but overhunting in recent years has depleted game stocks (Anderson and Medina in prep.). Seventy percent of the ejido is covered with forest, all of it in various stages of regrowth from past cultivation. Some logging is carried out, but valuable woods were depleted in the

early 1990s. Stockrearing and beekeeping are important. The vast majority of the population is highly knowledgeable about forests, fields, wild and tame animals, medicinal herbs, insects, and indeed all aspects of the environment. Given the solidly agricultural nature of the community, this knowledge is of a pragmatic, experiential type, fitting well into the wider model of "ecology of practice" developed by Nyerges (1997).

Research in Chunhuhub lasted for six months in 1991 and six more in 1996, with almost annual visits during intervening years. I was joined in the field by Eugene Hunn during a month in 1991; he introduced me to Felix Medina Tzuc, who became my collaborator and field assistant. Dr. Hunn also recorded bird voices in the field for Maya experts to identify (Hunn 1992) and worked with Don Felix and myself on seeing how far Maya could go in identifying birds from pictures in Peterson and Chalif's guide to Mexican birds (Peterson and Chalif 1989). Otherwise, research consisted primarily of walking through Chunhuhub and neighboring ejido and ranch lands, observing birds in the field and obtaining Maya identifications. I also listened to a great deal of Maya conversation about birds and other biota, including a great deal of discussion and argument over just what to call a particular bird. Since I was studying "referential practice" (Hanks 1990), rather than in the psychology of classification, I found it expedient to spend a great deal of time in the field listening to actual practice, and made minimal use of formal eliciting techniques beyond the frame interviewing described by Frake (1980). Thus, the following data refer strictly to name usage in ordinary conversation. I did not carry out experiments of the sort done by Atran (1999) and others, since I was interested, at this stage of research, in different questions (see Hanks 1990 for discussion and justification of the referential-practice approach in studying Maya; however, experimentation will be carried out in future research, opportunity permitting).

The Maya do not have a concept of "science" in the modern international sense. They do, however, have a reasonable equivalent. It is based on the core term ***k'aj*** "to know." Connected to this is the complex word ***ool***, which means "heart," and by extension "knowledge, will, condition" (and sometimes also "lungs" and other internal items near the heart). Uniting these, we get ***k'ajool***, "to know something, to recognize," and thus the verbal noun ***k'ajoolal*** "knowledge." This is as near as we can get to "science." It is not a far reach; ***k'ajoolal*** focally signifies practical working knowledge.

This article focuses on classification and uses of birds, with some comparisons to bird representation in contemporary international biological science.

MAYA BIRD CLASSIFICATION

Classification is often described as "carving nature at the joints." This, of course, assumes that nature has joints. How similar are Maya bird taxa to those of contemporary biological science?

In ethnoornithology, as in science wars, there is a range from social-constructionist to realist positions. No one is as extreme as Feyerabend (1987), but Ellen (1993), Forth (1996), and to a degree Bulmer (1967) stress social factors, and Ellen

has been sharply critical of narrowly realist models. Conversely, Boster (1987; Boster, Berlin and O'Neill 1986; Boster and d'Andrade 1988) and Hunn (1977) seem more prone to assume people recognize categories that are real in the sense of evolutionary biology. Atran (1990) and Berlin (1992) take a relatively strong position: people are mentally programmed to recognize the multistranded similarities that evolutionary relationships provide, and thus do carve nature at the joints. Atran's later position seems considerably more qualified and nuanced, due to his prolonged study (including use of psychological experiments, in collaboration with psychologists) of Itzaj Maya classification (Atran 1999).

The Yucatec Maya data are consistent with the position that the Maya recognize groupings that are natural in the sense of evolutionary biology. However, use and other cultural and social factors enter into and shape the classification system. The system can be understood only by taking both culture and nature into account.

Maya bird names are mostly at a level that Brent Berlin (1992) calls "folk generics."[2] These are usually one-word names. They contrast with each other; to place a bird in one folk generic means it is not in any of the others. They are sometimes broken down into "folk specifics," which are normally formed by adding an adjective to the generic. Thus ***ch'om*** means "vulture"; ***chak pool ch'om***, "red-headed vulture," is the Turkey Vulture (*Cathartes aura*). Maya, English, and Latin, like most languages (Berlin 1992; his usage is followed here, rather than that of Atran 1999, more for convenience than because of any deep theoretical reason), use the classic pattern in which a folk-generic name is modified by an adjective to produce a specific. (The Greco-Latin genus name *Cathartes*, roughly "one who cleans up," covers one or two other vulture species; *aura* comes from a Native American name for this bird.) Latin terminology has many higher categories—the familiar phyla, classes, orders, and families of Linnaean taxonomy. Maya terminology has only one: the unique beginner ***ch'ich'*** "bird." Maya also has very few folk specifics. Almost all classifying of animals and plants is done at the folk-generic level. (This is true in most Native American systems.)

Of the 89 named terminal taxa (folk genera not broken down, or folk species) listed in the Appendix below, 63 have a one-to-one correspondence with the species recognized by international ornithology. Ten are focus-and-extension names: a focal species whose name is extended, more or less often, to other birds that are seen as distinct but are not named. In 9 cases, a terminal taxon is a Linnaean genus (4 cases), part of a genus (2 cases), or a group of closely related genera (5 cases). In 3 cases, a terminal taxon names a whole family, and in one case a name covers two unrelated but very similar families (***kusuun***: swifts and swallows). One name—only one—is a broad, vague category without Linnaean counterpart.

In two cases, a folk generic is broken down into folk specifics, all of which have a one-to-one correspondence with the international ones. One of these folk generics corresponds to a Linnaean family, one to a pair of closely related Linnaean genera.

In addition, I identify 13 groups, loosely named or named by extension of the name of one of their species (see below). Of these 13 larger groups ("folk families"), one corresponds to two (Linnaean) orders, two to an order, six to a family, two to part of a family, and two to a genus.

Many small birds are not considered important enough to have names of their own. These are lumped into broad, vague categories that may or may not resemble international scientific taxa.

These groupings are of two kinds. First, there are some genuine categories that are well-bounded, well-recognized, and correspond loosely to international taxonomic units. An example is provided by flycatchers of the Linnaean family Tyrannidae. These are divided into three groups in Maya: ***takay*** "large yellow-bellied flycatchers," ***juiiro*** "large flycatchers that have a loud call that sounds like ***juiiro***," and ***yaj*** "small flycatchers." These groups are seen as related, as is proved by the fact that ***juiiro*** (a rather exotic term) can be lumped with either ***takay*** or ***yaj***. It is explicitly recognized that these groups are diverse. Felix Medina Tzuc, for instance, pointed out to me the only pair of Piratic Flycatchers that we saw in our many months of co-work, and explained: "That ***takay*** is taking over the nest of those orioles." It was, indeed, doing that, but not so obviously that Don Felix could observe it on the spot; he relied on his knowledge of the bird. The Piratic Flycatcher (*Legatus leucophaius*) is a rare bird in Yucatan, and only a person with a great deal of field knowledge would realize that it is a special sort of yellow-bellied flycatcher that takes over the nests of other birds rather than building its own. It does not have a special name in Yucatec Maya, but it is recognized nonetheless.

To some extent, there is a "focus and extension" semantics here. ***Takay*** most commonly refers to the Couch's Kingbird (*Tyrannus couchii).* ***Yaj*** has a definite focus: the small *Myiarchus* flycatchers. These birds have a miserably mournful-sounding call, like a child whimpering "***yaj!***" ("pain!" or "I hurt!"). No other small flycatchers call like this, so the name qualifies as an extension. Another type of broad category is much vaguer. "Little brown birds" are all vaguely lumped as ***yankotij***, a name which properly belongs to the Tropical House Wren. (This is clear from its literal translation: "The one under the wall." Only Tropical House Wrens forage and nest in the stonewalls of the Maya house compounds.) "Little yellow birds" are all vaguely lumped as ***chinchinbakal***, a name that has no generally agreed focal referent. It covers goldfinches, warblers, small yellow-marked tanagers, and much more.

Several other names can be extended ad hoc. The ones that can be extended are known and constantly used to label some unknown bird. Other names are never extended. Unknown medium-sized red birds, such as migrant red tanagers, are lumped as ***chakts'its'i*** ("the red bird that says ***ts'its'i***")—a name that properly belongs to the Northern Cardinal (*Richmondena cardinalis).* By contrast, ***sojlin*** "ant-tanager" is not normally extended; if it is used for anything but an ant-tanager, the extension is regarded as a mistake. ***Ts'apim*** "saltator" (*Saltator* spp.) is extended to any medium-sized brownish bird of unknown identity. ***K'ok'*** "Clay-colored Robin" (*Turdus grayi*) is extended to cover any robin-like bird, such as wintering thrushes from North America. ***Pich'*** "Melodious Blackbird" (*Dives dives)* is the name used for unknown birds that are smallish and black.

A very different type of extension is the use of one common name to cover a natural group. In these cases, the name contrasts at two levels: (1) in its normal or proper referential usage, it applies to one species; (2) in its extended usage, it applies to that species and the natural group it is in. A common case is ***t'uut***, properly the White-fronted Parrot (*Amazona albifrons*—by far the commonest parrot in the

area). This name is extended to cover all parrots (though not parakeets). In particular, the Yucatan Parrot (*Amazona xantholora*), ***ek'xikin*** "black ear" in Maya, looks very much like the White-fronted and often travels with it; the two species are collectively ***t'uut*** to everyone, unless and until the distinctive black earpatch can be seen. Similarly, woodpeckers can be collectivized under the term ***k'olonte'*** (or sometimes ***che'hun***); quail under ***bech'***; hawks under ***ii'*** or ***chuy***; and a few others as noted in the Appendix.

Hofling and Tesucún (1997), in their dictionary of Itzaj Maya (which is very close to Yucatec), treat these generalized terms as higher-level taxa that might be called "folk families." Thus, they treat ***ixt'ut (=t'uut)*** as a general term for parrots, with the several folk generics (including ***t'uut*** in its more restricted sense) grouped under it. Yucatec does exactly the same. The Itzaj use ***ixpaloomaj*** (the Spanish word *paloma*, Mayanized) for pigeons and doves; Yucatec has a similar way of labeling pigeons by extending the term ***ukum***. Hofling and Tesucún (1997) also introduce a range of gender and environment categories that seem to cross-cut rather than structure the Maya general purpose taxonomy. This is problematic for the comparative nomenclaturist. In particular, their separation of tame and wild birds under totally different headings is certainly not the Yucatec pattern. However, in general, Hofling and Tesucún's Itzaj classification is very close to Yucatec, though their lumping of blackbirds and anis seems definitely not a Yucatec view, and their lumping of quails and tinamous in a "covert category" of "ground birds" (1997:76-77) seems rather ad hoc.

Atran's excellent work on the Itzaj (1999) has gone into a different realm: categories psychologically real to his specific consultants, as shown by tests in the field. These categories include "fish-eating water birds,...edible fruit-eating ground birds,...edible fruit-eating tree birds,...inedible flesh-eating birds,...inedible fruit-eating birds," and "inedible blood-sucking birds [i.e., vampire bats]" (Atran 1999:172-174). None of these have emerged as categories from any work done by me or others in Yucatec. It is notable that the category of "edible fruit-eating ground birds" has a very different composition from Hofling and Tesucún's similar category, though the same people were talking about the same general set of birds. Similarly, "inedible flesh-eating birds" includes groups that Hofling and Tesucún and the Chunhuhub Yucatec both separate into a "hawk" group and an "owl" group. The other assemblages found by Atran are even larger and less well defined, and nothing like them emerges from Hofling and Tesucún's data or from mine; they appear to be categories arrived at by testing for psychological similarity, and are certainly not part of a linguistic taxonomy.

Hunn (1977) treats Tzeltal bird names similarly, recognizing "groups" that are, de facto, folk families—natural groupings as recognized by the Tzeltal, but not named as formally as the folk genera are. These, again, are similar to Yucatec and to Itzaj (Hofling and Tesucún 1997), but also include several other sets that he calls "complexes. Most of these are the same, or much the same, as Yucatec (hawks, vultures, doves...). Others include montane Chiapas species outside the knowledge of Yucatec observers. However, some groupings psychologically real to the Tzeltal would seem exceedingly far-fetched to the Yucatec, e.g. the link of squirrel cuckoos with quail (Hunn 1977:153-5) or of trogons and motmots (Hunn 1977:169-170). Hunn found the wide groups of waterbirds and black birds that Hofling and

Tesucún found and that seem nonexistent for the Yucatec (except in so far as the latter use the general descriptive term ***ch'ich' ha'***, "water bird"—without any implication of real relationship).

Such groups blend into the "covert categories" of Berlin and his students. I am very loath to invoke covert categories without proof that the people in question really do think that a group is a real category. I think that wider-than-generic categories are clearly shown by extension of terms, if reliable and predictable—not purely ad hoc like the extensions of ***ts'apim*** and ***chakts'its'i***. But one must work constantly in the field, with consultants, to make these distinctions, and even then they could be challenged. I have done it in the appended table, but I have done it with great care—only when a group is explicitly and reliably named by an extended term, and I have independent interview data suggesting that the group is seen as a natural one. The extension of terms like ***t'uut*** and ***k'olonte'*** does most certainly show that the Maya recognize the parrots and the woodpeckers as natural categories. The extensions are thus of considerable interest.

All this reveals a pattern (the Yucatec one is very similar to the Itzaj one described by Atran 1999). Big, obvious, or useful birds have their own names, which, though "folk generics," correspond with the species of Latin taxonomy. Small, rare, or unobtrusive birds are referred to by names that are also "folk generics," but that do really correspond to genera or even families. Very small, insignificant birds are simply lumped with the most convenient and well-known small bird of the same color.

Consider the guild of woodpeckers and trunk foragers:

The area's five common species of woodpeckers are abundant, obtrusive, noisy, confiding, and impossible to miss. They are parceled out under three names (two almost identical species being lumped as ***kolonte'***, and two as ***che'hun***; either is sometimes extended to cover woodpeckers in general).

Woodcreepers, though equally diverse in the area, are much less common, less easy to observe, and dull in color. They have only one name, ***tatak' che'***, corresponding exactly with the Linnaean family Dendrocolaptidae.

Small trunk-foraging birds (such as the Plain Xenops, *Xenops minutus)* are rare and obscure. They have no names at all, but, when noticed, are lumped under the garbage-can category created by extension of ***yankotij***.

Similarly, all game birds have their own names, but various non-eaten birds of equal size and obviousness are lumped into broad categories. Hawks are lumped into form-classes: each group with a distinctive flight profile, or appearance in flight, has its own name. This causes some interesting debates about e.g. the position of the White-tailed Kite (*Elanus leucurus*), which has pointed wings like a falcon and thus could be a ***k'eenk'eenbak'***, but is large and heavy-bodied and pale like an ***ii'*** (focally the Gray Hawk, *Buteo nitidus*) and thus could be in that category. Maya discussions of such issues while away many a sleepy hour, and remind the visiting ethnographer of debates among ornithological taxonomists.

One significant observation is that none of the wintering birds from North America is named. Though Yucatan is vitally important as a major wintering ground for many midcontinent species, with Chunhuhub alone playing host to thousands of birds, not one has a Yucatec Maya name. (One, the Indigo Bunting *Passerina cyanea,* has the Spanish name *azulejo*. In other areas of the Peninsula, migrant war-

blers are collectively referred to by the onomatopoeic word ***ts'ip***, but I have not heard this word used by Chunhuhub Maya.) Instead, the migrants are the major beneficiaries of the loose extension of words like ***yankotij*** and ***chaktsi'tsi'***.

In short, nature has joints, but society sometimes sees every reason not to recognize them. When birds are useful or too obvious to ignore, they get their own names, which cover exactly the same space as a Linnaean species. To the degree that birds are useless and otherwise nonsalient, they are lumped into progressively wider and vaguer categories. Most of these categories correspond to the larger Linnaean taxonomic units: genus, family. Then, as terms are extended out to birds that are not only insignificant but do not even breed in Maayab ("Maya land"), the terms cease to have any relation to Linnaean categories. Instead, they lump birds roughly by size and color. (As a matter of fact, the same was true of early European taxonomy, and Linnaeus himself did some broad lumping.) However, all of them have a focal exemplar that is a real, well-recognized Linnaean species or tightly-knit group. The only exception is the catchall term *chinchinbakal*.

In other words, almost all Maya taxa, when not loosely extended, correspond exactly with Linnaean taxa—at the species level, if the bird is salient; otherwise at the genus level (but only if the genus is tightly knit, with all local species similar) or at the family level. The less salient the birds, the more wide the Linnaean group that equates to the labeled group in Yucatec. Some families (hawks, flycatchers) are parceled out in ways not like those of international ornithology, but the parceling does make a great deal of sense in terms of the realities of Chunhuhub. They accurately label natural-seeming groups, united by appearance and voice—even when they cut across Linnaean taxa (as they sometimes do—but only in marginal extensions of the terms).

One concludes that classification is a social construction, but one that must take account of real natural differences if it is to be of any use at all (cf. Atran 1990; Berlin 1992; and literature reviewed therein). Since the Maya and contemporary international biologists are both trying to find useful labels that represent some sort of external reality, there are many similarities in the two systems. Since the uses in question are not the same, there are also differences—largely at the level of "lumping." The Maya lump species that are unimportant to them. The biologists find all species equally important—at least in the Class Aves. However, biologists too lump things they do not find salient. I am told by colleagues that the few thousand recognized species of nematodes could probably be split into hundreds of thousands (if not millions) of species, if nematode taxonomy were as developed as avian taxonomy. Thus, one does not expect, and does not find, quite so good a fit as one would expect from some of the work of Boster (1987; Boster, Berlin and O'Neill 1986; Boster and d'Andrade 1989) or of Atran's earlier theorizing. Maya extension of terms fits well with Boster's findings that broad visual similarities serve as primary markers of relationship, and also with Boster's observation that Native American peoples are prone to name birds from their vocalizations. This affects classification; flycatchers, for instance, are broken down as much by vocalization as by appearance. The Maya also consider behavior and habitat in making identifications and classifications. The term ***pujuy***, for instance, is extended to birds that act like the focal ***pujuy***.

MAYA BIRD USE

Knowledge of the uses of birds is straightforward, but not without interest in the present connection. The most important use is as food. In addition to domestic fowl (chickens, ducks and turkeys), several wild species are hunted—especially quail, tinamous, chachalacas (***bach***, *Ortalis vetula*), and the very few larger game birds still found in the area. Wild birds are also kept as pets, especially parrots, parakeets, doves and pigeons, and-rarely now—large game birds.

Birds for food are usually shot with shotguns or rifles. (Maya hunters wingshoot quail with ancient .22s, a feat that would awe any Anglo-American shooter.) However, small birds, and all birds wanted as pets, are caught with traps and snares. Most common is a simple box trap, usually used by boys to get pets. Small birds are baited in, and the boy pulls a string that removes a twig holding up a small box. It falls over the birds. This is sometimes used more seriously, to get quail for food. Nooses, snares, and sticky materials are occasionally used to catch small birds. Sometimes a *batea* is staged: a hunt in which men form a long line and beat the bush for game. Birds, however, are not successfully hunted this way, since they fly off.

Birds are occasionally used as indicators of time or the like. For instance, the Bright-rumped Attila (*Attila spadiceus*—one of the ***juiiro*** flycatchers) is sometimes called the ***pak'sak'al***, "plant-the-brushfield," because it sings loudly at the time of year when a farmer should be doing that. The noise of feeding birds can attract one to wild fruit. Last of all, some birds, especially parrots, parakeets, and jays, are often pests of the milpa fields. They must be controlled by scaring them away, and—in desperate cases—by traps, slingshots, and guns. The Maya of Chunhuhub love and cherish birds, and will not kill a pest bird unless its depredations become devastating.

To this extent, knowledge is highly pragmatic. Social construction enters the picture to the extent that only the larger and tastier birds are defined as edible; no one would eat a hawk, toucan, or other large but non-choice species unless hunger was serious.

However, a different kind of knowledge exists. Many birds are associated with various sorts of dark powers. These fall into two categories: Ominous birds and birds used in magic.

Ominous birds are the nocturnal species, considered unlucky through both indigenous Mexico and traditional Spain. The Barn Owl (***xooch'***, *Tyto alba*) is particularly feared; its loud and hideous shriek presages death. Even the common little ***pujuy*** (nightjar or pauraque, *Nyctidromus albicollis*) is worrisome. When it calls and jumps up after insects, it presages death. Since hundreds of ***pujuy*** call and jump all night, every night, in Chunhuhub, one would expect many deaths—and, sure enough, every day, several people die in Mexico. Since any death, anywhere, counts as a "hit," the predictive value of the ***pujuy*** is confirmed. Some Maya also believe the loud, wild call of the peppershrike (***ch'uyin***, *Cyclarhis gujanensis*) is ominous.

Chunhuhub seems not to have imaginary birds, but other areas of the Yucatan's Maya world have reported such animals. From Chan Kom, the most intensively ethnographized community in the peninsula, we hear of the purple ***taankas*** par-

rot (Redfield and Villa Rojas 1934; ***taankas*** means any mental problem from numbness to frenzy) and the eagle witch (***way kot***; Re Cruz 1996), apparently a witch that can transform into an eagle. I have heard of a bird similar to the ***taankas*** parrot in other nearby communities.

Other birds are useful in working magic. Magical practices are carefully and sharply distinguished from standard medical and pragmatic knowledge, by being labeled with the Spanish words *mágico* or *secretos*. A specific magical practice is a *secreto* (and it is said that "women know seven *secretos* to men's four"). This word is not used for practices, even esoteric ones that do not involve dealing with dark or suspect supernatural powers.

Commonest of *secretos* is the use of hummingbirds, ***takay***, and ***pujuy*** for love magic, in that order of abundance. The bird is caught on a Tuesday or Friday—these being the "bad days" of the Catholic church calendar—and dried. Dried hummingbirds are carried in the pockets of young men for love magic (as is true throughout Mexico). The powdered head of a dried hummingbird or ***takay***, thrown on a girl as she enters church, makes her fall madly in love with the thrower—at least, if he knows and uses the right charms. A ***pujuy*** head is sometimes so used, or the ***pujuy*** powder can be used in cursing. The ***t'unkiya*** (another nightjar, *Caprimulgus salvini*) can also be used for this. Some magical medical charms involve these birds.

Other witchcraft includes the magical introduction of live scorpions and the like into people, but birds seem not often involved in these practices.

There were times when avian magical medicine was much more important. The Rituals of the Bacabs, a collection of long ritual curing chants that seem to be pre-Columbian, includes many birds. Jays, woodpeckers (***kolonte'***, *che'hun*), and above all macaws (***moo'***, *Ara* spp., now extinct in the Yucatan) were particularly important. They are invoked in many of the long chants. Often, they are associated with fire, and with the curing of insanity. The extremely arcane and difficult Maya of the chants almost precludes serious study at this time, but there is a major future study of Bacab biology to be done.

Obviously, we have been moving farther and farther from anything that could be verified by actual experience with nature. The edibility of birds is common experience. Their value as pets is a matter of opinion, cultural as well as personal; at the least, some of them can be tamed and make affectionate housemates. The omen value of night birds is clearly nil to the outside scientific observer, but the Maya can point to an almost perfect correlation between nocturnal calls and someone dying somewhere. This, then, is a judgment call in which "social construction" really does allow many different results. Love magic is more difficult to defend, since everyone admits that it rarely works.

Finally, we enter a realm in which no amount of personal experience can allow entry. It is quite safe to say that no one has really seen a purple ***taankas*** parrot or the flaming jays of the Bacab songs. No one (to my knowledge) believes in them in Chunhuhub; Chunhuhub is a particularly pragmatic, down-to-earth place. But Chunhuhubians believe in other supernaturals that would seem to the outsider to be just as difficult to observe, such as the ***aluxoob*** (tiny beings, usually thought to be ancient Maya sculptures that can be animated by the right methods). Some

have seen the ***xtabay*** (the demon woman). However, it is admitted that one usually sees the ***xtabay*** only after consumption of a large amount of alcohol. This is traditionally thought to be because she finds drunkards particularly vulnerable to her evil charms, but skeptical Maya are quite aware of the obvious alternative explanation.

In short, there is a realm, marked off in Maya thought, in which social construction has really run far beyond any observable or verifiable reality. This is a realm in which love, death, and fear are paramount. There are countless anthropological theories of magic, and it would be tedious and irrelevant to catalog them here. Suffice it to say that almost all agree that, in these areas, human fears and desires press irresistibly hard against the boundaries of observable reality. It is by no means clear if any culture, including the culture of professional psychologists and doctors, has any solution to the problems of ruling love and predicting death. This does not stop most people from believing they can "have dominion over Judgment Day" (as the traditional blues line has it), or at least over love. Exploring these issues is outside the realm of this paper.

There is no explicit body of theory holding Maya bird knowledge together, but one could, with Gonzalez (1998), formulate assumptions. First, it is assumed that birds that look alike and sound alike are natural categories. If the birds are essentially identical, they must be in one category, and if lumped they are lumped with similar birds. No Maya, and probably no one on earth, would classify king-birds, horned owls and cormorants in one group opposed to another group made up of small flycatchers, barn owls and grebes. Social construction does not work that way. Second, there is an assumption that all things are potentially useful for filling material needs, and that all things large enough to be interesting should be explored for their value in these areas. This assumption has led to the accumulation of a great deal of lore about birds as food and as pets, and how to obtain them. Third, there is an assumption that love, harm, and some kinds of fate can be controlled by use of *secretos*, and that birds are useful in this enterprise. Certain birds are earmarked for the tasks of magic.

DISCUSSION

Culturally standardized, traditional knowledge is, by definition, 100% socially constructed. However, as Marx said of history: "Men make their own history, but they do not make it just as they please"(Marx 1986:277). Observed external reality provides constraints that cannot always be ignored. One cannot indefinitely believe in the safety of consuming deadly poisons, or walking off cliffs. Even if an individual did so believe, a culture would not encode the belief. Experience to the contrary would be too commonly observed.

The Yucatec Maya live as subsistence farmers in a harsh environment. They survive only through having a literally encyclopedic knowledge of soil, water, useful plants and animals, and useful farming techniques. Unlike academics at prestigious universities, they do not have the luxury of believing anything they wish or of dismissing the real world. Instead, they must constantly interact with nonhuman reality. They walk a razor edge; the least mistake, the least failure to invoke the correct strategy, can mean death.

Accurate knowledge does matter. Chunhuhub residents tell that some years ago, two young Dutch hikers got lost in the woods near Chunhuhub. They died of thirst in the waterless bush. The forest where they died was festooned with wild grapevines (***saya ak'***, *Vitis* spp.). Every experienced Maya knows these grapevines, and knows that they store water, containing up to a cup or more of clear, pure water per linear meter of vine. The reason why this knowledge is so widespread is grimly obvious from the fate of the unknowing Dutch youths.

The more one knows about farming and about ***baalche'*** ("things of the trees"—wild animals), the better one lives. The forest provides, for those that truly know it well, a good living, and even a few luxuries such as pet birds. Moreover, the Maya yield to none in their enjoyment of the wild birds. They love the songs and color as much as medieval European poets seem to have done. Enjoyment, too, leads to knowledge and to its social construction. Many a Maya bird taxon appears to be widely recognized simply because the birds in question are so amusing, or beautiful, or delightful. This, too, is a use of nature, and a socially constructed one; but it requires the existence of the birds, and the potential to enjoy them.

Interaction with nonhuman lives should not surprise those who believe in "the social construction of reality" (Berger and Luckmann 1967). After all, social construction can only arise from people interacting and discussing. It cannot exist unless people actually do see and respond to an external reality—the reality of the others they meet and the communication transactions they experience in dealing with those others. If people are interacting with each other and learning from that, it seems hard to deny that people interact with birds also, and learn something of the avian world.

So ecological knowledge, like other knowledge, arises from practice (Nyerges 1997). It arises from interaction between people who are interacting with the nonhuman world. It is phenomenological, but a phenomenology based on sensory experience (Abram 1996).

When "nature fights back," refusing to let people ignore it, society can construct knowledge only within strict limits. If people want to use birds, the need for an adequate classification system is strongly felt. This is a place where Nature really has joints, if not always clear and obvious ones. People need to "carve Nature at the joints" if they are to deal effectively with birds and communicate effectively about them. As a result, classification systems from around the world look somewhat alike. On the other hand, society and history play a role in determining which birds are used, which are held salient, which are ignored. Social construction determines which are recognized as species, and which are lumped into broad vague categories.

Berlin (1992) has demonstrated the similarity of classification systems around the world, and the similarity of many systems to modern scientific taxonomy. This he ascribes to a tendency of humans to perceive certain sorts of discontinuities and continuities in nature. It is perhaps more accurate to say that people perceive all sorts of things, but interact with humans and with other lives so much that everyone, eventually, tends to realize that some differences matter and some do not. The differences between different quail species are real, and matter to the Maya. The differences between small flycatcher species are equally real to a biolo-

gist, but are of no special consequence to the Maya, who therefore ignore them (cf. Boster and d'Andrade 1989). Overall, the Maya data fit much better with the findings of Boster and his associates than with those of more social-constructionist scholars. However, it is noteworthy that the latter (e.g. Bulmer 1967; Ellen 1993; Forth 1996) have often been those who carried out research in east Indonesia or in Papua-New Guinea, areas where systems may be genuinely very different from both Maya and western models.

However, different Maya groups, and even different Maya consultants within the same group, obviously classify birds in different ways. This is not so much a matter of failing to perceive relationships as of devising classifications that fit one's own referential and ecological practice (Hanks 1990; Nyerges 1997). In particular, birds are lumped ad hoc if there is no special better reason to lump them, or if there is no pragmatic reason to see them as deeply and basically separate.

Words, after all, are to talk with, and there is no sense providing a verbal label for something one does not talk about. Conversely, "utility" in the narrow sense originally adduced by Hunn (1982) did not exhaust the reasons why people might want to talk about something. They might want to talk about it only because it is common and has a pretty song, and is thus hard to ignore if one loves birds as much as the Maya do; thus there are not one but two names for the singularly "useless"—but pretty and songful—Yellow-green Vireo (*Vireo flavoviridis*).

Even classification systems get confused with power relations, as Foucault (1971) showed for the Linnaean system; one need only look at its hierarchy, with "Kingdoms," "Orders," and "Families" duly arranged by relations of inclusion. I find no evidence that the Maya system was concocted with one eye to the State, even though the ancient Maya did have states. But one cannot be sure. If relations with the natural world and with fellow farmers are clearly reflected in the system, relations with the hierarchy may also be. The weird birdlore reflected in the Rituals of the Bacabs may well have a great deal to do with politics. We do not know.

Moreover, as belief gets uncoupled from immediate observation, society can construct with a much freer hand. In international biological science—and, even more, in high-energy physics and in astrophysics—much high theory is purely speculative. Theorizing runs far ahead of observation. Conversely, sometimes a new theory is irrationally rejected for decades, until the buildup of supporting facts is so overwhelming that no one can deny it any more (see Oreskes 1999).

Of course, the ideal of testing it is there; but by the time a theory is adequately tested, theorists have already gone on to even wilder flights of imagination. It should, then, surprise us not at all that the hardheaded and pragmatic Maya farmers believe some very improbable things about birds.

To the dispassionate anthropologist, the mistakes people make seem remarkably similar. As our felt needs for knowledge outrun our possibility of checking, we come to believe some very improbable things. In so far as a whole society is made up of people with such needs and such biases, a whole society can construct a whole system of knowledge that is far from observed reality. This is as true of 20th century scientists as of Maya farmers. Against the Maya use of birds in love magic, we can set the enormous amount of speculation on love that fills rack after rack in any bookstore. Much of this material seems to the uninitiated to be as far

from any observed reality as are the beliefs about the use of powered ***takay*** heads. It is not only the Maya whose need to deal with love runs far beyond their ability to understand it.

In Mayaland and in the modern laboratory, observations are usually good and accurate, unless driven by powerful antecedent beliefs. This is because people can check their observations against reality, on frequent occasions, and thus are disabused of the minor errors that derive from unquestioned assumptions, sheer ignorance, and mistake. Interpretations and explanations, in so far as they are decoupled from direct observation, are increasingly tentative. Accordingly, they must be more and more self-consciously tested against reality. At no stage is the process free of bias and social construction, but at no stage is the process so removed from reality-testing that it is pure construction in a vacuum.

CONCLUSION

There is, then, a universal search for truth. We can use the term "science" for this worldwide search for more and more accurate data and understanding.

However, every culture, every society, has its own unique form of "science," and systems of knowledge are indeed socially constructed, in a very literal sense. It would thus be possible to limit the term "science" to the activity defined by Bacon, Galileo, Boyle, et al; however, the restriction of the term to contemporary institutionalized Big Science is absurd, and the restriction to formal, positivist work (a restriction still made by e.g. Cronk 1999) is not only absurd but flagrantly violated by almost all working scientists (Hacking 1999; Kitcher 1993; Kuhn 1962).

Even the limitation to post-Baconian experimental practice may be seen as arbitrary and Eurocentric. "Science" is a highly prestigious label in modern society. Refusing to use Egyptian, Greek, Chinese, Near Eastern and Maya traditional knowledge systems seems undesirable, not only because it would add to the already great amount of bias in the world, but also because it might lead contemporary scientists to slight traditional knowledge.

Knowledge is socially constructed, but *it is through the very process of social construction*—inevitably involving interaction, checking, and feedback—*that accurate, empirically useful knowledge can be increased, refined, corrected, and made more valuable*. Mistake-making is an inevitable cost of this system. Science flourishes in so far as people keep interacting with the world, to verify or disprove the speculations they have entertained and the conclusions they have reached.

Because of differences in this and in entire social contexts, knowledge systems in different cultures can look very different. They can also look similar, especially when they are under constant tight control by feedback from the actual "world out there." The degree of similarities between systems, and the degree of arbitrariness that enters into socially constructed knowledge systems, are matters for empirical investigation.

NOTES

[1] I avoid the term "western science," because contemporary biology is an international, not a western, project; Chinese, African, Indian and other scientists have made major contributions to it. "Western" science, conversely, still includes a great deal of lore (such as the

humoral medical theory, still common in western folk societies) that is no longer part of formal biological science. And, anyway, the Maya live west of Europe. "Western" science is an obsolete and misleading, not to say prejudicial, term for international science in today's global society. Writers such as Wolpert (1993) restrict the term "science" to the west, usually through ignorance of what other cultures are doing. Wolpert, for instance, states that "the Chinese, often thought of as scientists, were expert engineers but made negligible contributions to science. Their philosophies were essentially mystical…(Wolpert 1993:xii)." Even given Wolpert's restrictive definition of "science" (basically, post-1600 western experimental science, but extended to include ancient Greek speculation and modern nonlaboratory sciences), this statement is absolutely wrong, and demonstrates complete ignorance of Chinese science and philosophy—an ignorance more than confirmed by Wolpert's wildly inaccurate discussion of China (1993:46-47). His opinion of all "primitive" and nonwestern traditions is summed up: "…for thousands of years the mythology and cosmology of almost all cultures entertained neither a critical tradition nor curiosity about nature (Wolpert 1993:54)." He equates nonwestern knowledge-seeking, including Chinese and Islamic science, with a chimpanzee joining two sticks together to get bananas (1993:26). Yet—as an educated Englishman—he adulates the ancient Greeks, crediting them with the full Baconian-Galilean approach; this is, again, not accurate. It is surprising and depressing to find that claims of this sort can still be published in an academic work. Wolpert's work is also confused and inconsistent. He defines science in various ways, loosely classifiable into a broader definition and a narrower one. By Wolpert's broader definition (thoughtful observation leading to counterintuitive generalizations—"intuitive" meaning, loosely, "consistent with everyday rationality—biases and all"), all societies have science. (This is not helped by Wolpert's lack of clarity about just what is counterintuitive.) By his narrower one, only certain post-1600 sciences count. The latter definition would rule out taxonomy—contemporary biological as well as Mayan.

[2] There is no previous systematic account of Yucatec Maya bird names. Existing accounts such as those of Pacheco Cruz (1958) and Hartig (1979) are incomplete, out of date, and seriously compromised by major errors. (Pacheco Cruz does include a great deal of cultural material that is of great value—including a very large amount of magic and folklore, well beyond anything I encountered.) Itzaj Maya, which is virtually a dialect of Yucatec, has been more fortunate, having been the subject of two excellent studies: Scott Atran (1993, 1999) has provided lists of terms, and Charles Hofling, with F. F. Tesucún (1997), have provided an entire dictionary. This dictionary gives a list of bird names (pp. 72-77). This list breaks up the bird names into various categories, including use-categories, and provides a number of different sorts of higher-level taxa that might be called "folk families" (see above). One or two of these groupings seem highly idiosyncratic, and are certainly not psychologically there for the Yucatec. For instance, the Yucatec would not group anis with blackbirds. However, most of them are the same as the Yucatec groups. I have been more cautious in listing groups. For example, their category of ground game birds—named in Spanish but not in Itzaj—is probably real, in some sense, to the Yucatec too, but I have not listed it because it is not a Yucatec-named group. Presumably all of the groups listed in the dictionary are real to the Itzá; Tesucún is a scion of an old and powerful Itzaj lineage. However, on the whole, the arrangement of animals in this dictionary is somewhat different from anything familiar in Yucatec. Many names, too, have quite different usages from those common in Yucatec; for instance, ***ts'apim*** refers to orioles instead of saltators. They also use the diminutive ***ix-*** (equivalent to modern Yucatec ***x-***) wherever it is commonly used in speech; but the diminutive is actually an optional addition to the name, so I have not indicated it.

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APPENDIX.—Chunhuhub Yucatec Maya Bird Names and Their Correspondence with Linnaean Nomenclature

Maya is transcribed according to the system recently standardized and accepted for Maya languages. This system is still unfamiliar in Yucatan, but is winning rapid acceptance and is used in the newer literature. Only common, well-identified names are given. I have recorded several others that are either vague or need more research. Only the commonest Spanish names are provided. Unlike Hofling and Tesucún, I have not bothered to respell Spanish names in Maya transcription (see e.g. "***ixpaloomaj***" above). The people of Chunhuhub are bilingual, and usually pronounce the Spanish without any Maya accent. To respell Spanish names seems pedantic. Like other tropical American peoples, the Maya are fond of naming birds from their call. In the forest, birds are far more often heard than seen. Often, individuals do not even know the appearance of a bird well known by voice.

Class Aves: ***ch'ich'*** "bird"

Arbitrarily arranged in Linnaean order; no obvious order or high-level groupings arise from the data. Vague and tentative "covert" or ad hoc categories are often proposed, but I prefer to be conservative, staying with unquestionable data.

Tinamou cluster: ***Non***

Mankolom. Great Tinamou, *Tinamus major*. Does not occur locally, but known to locals who who have been farther south.

Non (nom). Rufescent tinamou, *Crypturellus cinnamomeus*. Common; a game bird, but not often obtained because of its extreme wiliness.

Ke'el non. Little tinamou, *Crypturellus soui*. In spite of a name that makes it sound like a subcategory of the foregoing, this is recognized as a different bird.

Kamacho. Olivaceous Cormorant, *Phalacrocorax olivaceous*. Spanish-sounding extension of *mach*, the more general Yucatec name. Extended to the Anhinga, *Anhinga anhinga*. I have heard the cormorant called *jichkal* but this seems nonstandard.

Kuts ha' "water turkey." Muscovy Duck, *Cairina moschata*. (More commonly just called *pato*, the Spanish for "duck." To distinguish it from the rarely found domestic mallard, it is called *pato criollo* "native duck.") Common domestic and rare wild bird. Used for food and as a pet.

Pijije. Black-bellied Whistling-duck, *Dendrocygna autumnalis*. Echoic. This is the Spanish name too, but it was probably borrowed from a Maya language or from Nahuatl.

Ch'om "vulture." One of the few named groups in which a true folk generic is broken down into folk specifics:

Batab ch'om "chief vulture." King Vulture, *Sarcorhamphus papa*.

Box pool ch'om "black-headed vulture." Black Vulture, *Coragyps atratus*.

Chak pool ch'om "red-headed vulture." Turkey Vulture, *Cathartes aura*.

Hawk group: All hawks are recognized as related, as is shown by the fact that they can all be covered by widely extending the terms ***ch'uy*** and ***ii'*** and by the Spanish *aguililla* or *gavilán*. Careful speakers, however, break out several other categories.

Ch'uy "large hawk." This term can cover any large hawk. ***Ek'pip***. Black Hawk-eagle, *Spizaetus tyrannus*. Extended to other hawk-eagles and large impressive hawks.

Ii'. Focally the Gray Hawk, *Buteo nitidus*, but used for any medium-sized hawk, especially pale-colored ones.

Sak ii' "white hawk." The Gray Hawk in particular—or, sometimes, any light-colored hawk—as opposed to other ***ii'***.

Jonkuuk. Harpy Eagle, *Harpia harpyja*. Now extinct in the area, but the name is well known to local residents, who remember the bird and describe it accurately. It also appears in the Colonial dictionaries, with unmistakable descriptions.

Koos. Laughing falcon, *Herpetotheres cachinnans*. Unlike the other hawk names, this one is not often extended.

K'eenk'eenbak'. Small falcons. Apparently the most typical, or perhaps even focal, one is the Bat Falcon, *Falco rufigularis*. However, the term is extended to any small-ish, pointed-winged bird of prey, up to and including the White-tailed Kite, *Elanus leucurus*, which is also called ***ii'*** and ***sak ii'***. The male bat falcon is called ***kiris*** or ***kiklis***.

Bach. Chachalaca, *Ortalis vetula*. There is some possibility that the chachalaca is seen to be related to the following four, but I have no evidence of it. Common; food item but usually too wily to kill. Also called ***kobi*** or ***koba***.

Kox. Crested Guan, *Penelope purpurascens*. Food. Now very rare.

K'ambul. Curassow, *Crax rubra*. *Faisán* in local Spanish. Food and pet. Rare.

Kaax. Domestic fowl, *Gallus domesticus*. Name derived from *Kastelan* "Castilian," a recognition of the introduction of the bird by the Spanish. A rooster is ***t'eel***, which must once have meant a male bird or male game bird in general.

Bech' group:

Bech'. Yucatan Bobwhite Quail, *Colinus nigrogularis*. Common. Potentially a food, but in practice too small and wary to be worth the trouble of hunting it.

Chibilub. Singing Quail, *Dactylortyx thoracicus*. Rare; potential food, actually too rare and well-hidden to hunt.

Turkey group: unlabeled but clearly recognized, and terminologically united by sharing special terms for tom and hen.

Uulum. Domestic Turkey, *Meleagris gallopavo*. Echoic name. Common; important food resource. Tom is ***tso'***, hen is ***tuux***.

Kuts. Ocellated Turkey, *Agriocharis ocellata*. Formerly important game bird, now almost exterminated by overhunting. I believe the tom and hen are labeled as in the preceding.

Gallinola. Gray-necked Wood-rail, *Aramides cajanea*. Also Northern Jacana, *Jacana spinosa* (when it is not given its proper Maya label). Extended to any other rails present (the only common one is the Sora *Porzana carolina*, a winter visitor). Water birds are so rare in interior Quintana Roo that Maya names have usually been replaced by Spanish ones—as in this case.

Correa. Limpkin, *Aramus guarauna*. Spanish name; probably a variant of the commoner Spanish *carao*.

T'eel ha' ("watercock"). Jacana, *Jacana spinosa*. Probably extends to similar birds.

Pigeon cluster; all lumped as *ukum* or under the Spanish term *paloma*.

Paloma. Rock Dove, *Columba livia*. Common tame bird. Since it is a Spanish introduction of no great age in the area, it has no Yucatec name.

Chuukij. Scaled pigeon, *Columba speciosa*.

Ukum (ukuch). Red-billed pigeon, *Columba flavirostris*. Echoic. This is the common pigeon of the area, and its name is routinely extended to mean "large pigeon in general," i.e. to cover the preceding species. Also called ***kukut'kib***, which name is also extended to the foregoing. Used for food, but rarely taken.

Sakpakal. White-winged Dove, *Zenaida asiatica*.

Tsutsuy. *Leptotila* doves and similar doves. Common is the White-tipped Dove, *Leptotila verreauxi*. Other species occur and are not distinguished terminologically, except for the Ruddy Quail-dove, *Geotrygon montana*, which is ***chak*** (red) ***tsutsuy*** or ***k'aankab*** (red-dirt) ***tsutsuy***.

Mukuy. Ground doves. Probably echoic. Three species:

> ***Chak mukuy*** "red ground-dove." Ruddy Ground-dove, *Columbina talpacoti*. Abundant; occasional pet.
>
> ***Sojol mukuy*** "leaf-litter ground-dove." Common Ground-dove, C. *passerina*. Rare.
>
> ***Tuch mukuy*** "ground-dove that calls ***tuch***," thus part-echoic. Blue Ground-dove, *Claravis pretiosa*. Common but shy and seldom seen.

Parrot group: recognizable by being lumped collectively as ***t'uut***.

T'uut. White-fronted Parrot, *Amazona albifrons*. Common; frequent pet. Also a frequent pest of milpas, eating maize, fruit, and almost anything else well above ground level.

Ek'xikin "black ear." Yucatan Parrot, *Amazona xantholora*. The Maya name hits home—it points to the one field mark reliably distinguishing this uncommon bird from the preceding.

Kocha'. Red-lored Parrot, *Amazona autumnalis*. Pet, but rare in the area. Also called ***kulix***.

Taadi'. White-crowned Parrot, *Pionus senilis*.

K'ili'. Aztec Parakeet, *Aratinga nana*. Abundant, and a very serious pest, descending in flocks on maize and fruit. Sometimes shot with slingshots when caught in the act. (Chunhuhub Maya do not usually, otherwise, kill even the worst pests.) ***K'ili'*** are never called ***t'uut***.

Baakenchulul. Pheasant cuckoo, *Dromococcyx phasianellus*. Extended to cover the Lesser Roadrunner *Geococcyx velox*, rare and probably a recent arrival in the area (coming with large-scale clearing of forest).

Kipchoo'. Squirrel cuckoo, *Piaya cayana*. Echoic.

Chikbu'ul. Groove-billed Ani, *Crotophaga sulcirostris*. Echoic, but folk-etymologized in that ***bu'ul*** means "beans," and anis often hide in bean vines.

Owls would seem a natural cluster, and this may be shown by their uniformly ominous significance, but they are always kept terminologically distinct, so far as I have heard.

Xooch' (or ***xiich'***). Barn owl, *Tyto alba*. Echoic. A bird of very bad omen; if it shrieks over a house, an inhabitant or relative will die. This common European belief may have been introduced by the Spanish.

Tunkuruchu'. Great Horned Owl, *Bubo virginianus*. Echoic. Also called ***bujk'aanij*** and ***xo'chikin***. A bad omen.

Kulte'. Mottled Wood-owl, *Ciccaba virgata*.

Chaxnuk (from ***chak xnuk***, "little red old man"). Ferruginous Pygmy Owl, *Glaucidium brasilianum*. Also a bad omen, but so common and tame that no one takes it very seriously. Name extended to other small owls. Also called ***koak'ab***, "the one who goes ***ko*** at night," which is, obviously, a part-echoic name.

Nightjar cluster: Identifiably a cluster because they are covered by the well-known, widely used Spanish term *tapacamino*.

Pujuy. Paraque, *Nyctidromus albicollis*. Probably echoic.

T'unkiya. Salvin's Nightjar, *Caprimulgus salvini*. (Probably also covers the rare Yucatan Will, *Nyctiphrynus yucatanicus*.) Echoic.

Jaap. Common Potoo, *Nyctibius griseus*. Echoic.

Ts'unuun. Hummingbirds in general. The many species found in Chunhuhub are not terminologically distinguished. Apparently echoic of flight sound.

Uulum k'aax "forest turkey." Trogons, *Trogon* spp. Echoic; name from similarity of call to turkey's common note. Several species occur and are seen as different, but they are not terminologically recognized. People in other areas say that ***kux*** is the correct name for the trogon.

Juj. Blue-crowned Motmot, *Momotus momota*. Echoic.

Toj. Turquoise-crowed Motmot, *Eumomota superciliosa*. Echoic. The Spanish name, often used, is *pajaro reloj*—"clock bird"—because this motmot regularly swings its long, pendulum-like tail from side to side.

Toucan cluster; recognized because the name ***panch'el*** is used for both species.

Panch'el. Collared Aracari, *Pteroglossus torquatus*.

Pitoreal or ***tucan***. Keel-billed Toucan, *Ramphastos sulfuratus*.

Woodpecker cluster; collectively called either ***che'hum*** or ***kolonte'***.

Che'hun. Golden-fronted Woodpecker, *Melanerpes aurifrons*. Often extended to the Yucatan Woodpecker *Melanerpes pygmaeus* and sometimes to other species.

Chi'pirix. Ladder-backed Woodpecker, *Picoides scalaris*. Name—or, usually, just the ***pirix***—sometimes extended to the Yucatan Woodpecker (which looks like a Golden-fronted but is smaller, about the same size as the Ladder-back). Name also extended to the male genitalia, as is the Spanish *picocarpintero* ("woodpecker") in Mexican folk speech.

Kolonte'. Lineated Woodpecker, *Dryocopus lineatus*, and Guatemalan Ivorybill, *Campephilus guatemalensis*. These two woodpeckers are very similar and tend to occur together. Even those who see that they are separate species tell me that the birds are too similar to be worth distinguishing! Probably an echoic name.

Tatak'che' (tak'ak'che'). Woodcreepers, family Dendrocolaptidae. A collective term. It is extended to cover the Smoky-brown Woodpecker, *Veniliornis fumigatus*, which looks and acts more like a woodcreeper than a woodpecker—though it is sometimes called ***che'hun***, too. The several species of woodcreepers are uncommon and hard to spot, and—again—even those who see they are different see no reason to recognize that fact terminologically. Echoic, but of the birds' pecking, not of their calls.

Sob (or, more rarely, ***pu'***). Barred Antshrike, *Thamnophilus doliatus*.

Flycatcher group: united by loose and sloppy use of the following three names—especially the first and last—to cover the whole group.

Bech' lu'um. Black-faced Antthrush, *Formicarius analis*. Also called ***tsiimink'aax*** ("forest horse")—a name also used, formerly at least, for the tapir. The reason for this naming is hard to imagine.

Takay. (This name is *always* spoken with the diminutive suffix *x*: ***Xtakay***. It is given that way in other works.) Large yellow-bellied flycatchers, focally the Couch's Kingbird, *Tyrannus couchi*, but including many species. Echoic.

Juiiro. Medium-sized brown forest flycatchers. Echoic; these all have calls that sound like ***juiiro***.

Yaj. Small flycatchers. Echoic. Focal is the Olivaceous Flycatcher, *Myiarchus tuberculifer*, whose mournful whistle does sound absurdly like a small child calling "***Yaj!***" ("I hurt!").

K'eo. Masked Tityra, *Tityra semifasciata*. Echoic. Extended to other tityras and similar birds. Name sometimes extended to ***peelank'eolij***.

Kusuun (kusaam). Swallows and swifts, collectively (families Hirundinidae and Cypseluridae).

Pa'ap. Brown Jay, *Psilorhinus morio*. Echoic. Never called ***ch'el*** or linked with ***ch'eloob*** in any way, so far as I can tell.

Jay group: ***Ch'el***. These could be thought of as two "folk species" of a "folk generic," or as two very closely related folk genera united in a broader group. In spite of its name, the aracari toucan does not seem to be regarded as a ***ch'el***.

Ya'ax ch'el. Green Jay, *Cyanocorax yncas*.

Ch'el. Yucatan Jay, *Cyanocorax yucatanica*. Probably echoic.

Yankotij. Wrens, and, by extension, all small brown birds. The focal one is the Tropical House Wren *Troglodytes musculus*, which is literally the "one under the wall" (see main text). Many other species occur but are not named separately.

Po'okin. Black Catbird, *Melanoptila glabrirostris*.

Chiik. Tropical Mockingbird, *Mimus gilvus*. Echoic. Often Hispanicized to ***chica***.

K'ok'. Clay-colored Robin, *Turdus grayi*. Echoic. By extension, any medium-sized brown bird that is at all similar, such as wintering thrush species from North America. Hispanicized to ***coquita***.

Ooxil. Yellow-green Vireo, *Vireo flavoviridis*. Name means "the one in the breadnut tree." Also called ***ts' i'kalants'i'***, which is echoic of the bird's commonest song phrase. One of the few cases of a bird with two names.

Ch'uyin. Rufous-browed Peppershrike, *Cyclarhis gujanensis*. Echoic. Extended to other birds with songs vaguely like "***chuyin***."

Sojlin. Ant-tanagers, *Habia rubica* and *H. fuscicauda*.

Ts'apim. Saltators, *Saltator* spp. Possibly echoic. Two species occur but are not distinguished. Name routinely extended to unknown birds that look even vaguely like saltators.

Ya'ax bech' lu'um ("green ground-quail"). Olive Sparrow and Green-backed Sparrow, *Arremonops rufivirgatus* and *A. chloronotus*. These two virtually identical birds are not distinguished. They are not regarded as related to the Black-faced Ant thrush, in spite of the similarity in name.

Azulejo. Indigo Bunting, *Passerina cyanea*. A Spanish name; there is no Yucatec Maya name, as is usual with winter visitors.

Chinchinbakal. Any small yellowish bird, including goldfinches, warblers, tanagers with yellow underparts, etc.

Pich'. Melodious Blackbird, *Dives dives*. Extended to other blackbirds that may occasionally appear.

K'aaw. Great-tailed Grackle, *Quiscalus mexicanus*. Echoic. Almost always said with the diminutive: ***xk'aaw***.

Ts'iu. Red-eyed Cowbird, *Molothrus aeneus*. Echoic.

Yuyum. Large orioles, focally the Alta Mira Oriole, *Icterus gularis*. Often Hispanicized to ***yuya***.

Jonxa'anij ("the one who nests in palmettos"). Smaller orioles, focally the Hooded Oriole, *Icterus cucullatus*, which is the one that really "nests in palms." There are controversies about where the rarer orioles fit, but usually they are called ***yuyum***.

Mut'. Yellow-billed Cacique, *Amblycercus holosericeus*. This name appears to be the Yucatec reflex of the widespread Maya root ***mut*** "bird." (***Ch'ich'*** is a Yucatec form that may reflect an ancient alternate root or may simply be onomatopoeic.) I do not know why the Cacique is "the" bird *par excellence*, but perhaps it is related to the tight pair-bonding of the birds (they always answer each other—the Maya assume one of the pair has died if a call is not answered). There are other indications that this is a very important mythic bird; see Anderson and Medina Tzuc, forthcoming.

K'uubul. Wagler's Oropendola, *Psarocolius wagleri*. Echoic.

Ethnobotany: A Reader. Edited by Paul Minnis. University of Oklahoma Press, Norman. 2000. $18.95 (paper). ISBN 0-806-13180-2.

Edited by Paul Minnis and intended as a review of important works in ethnobotany, this book aims to give the reader a broad impression of what the discipline encompasses. Designed as a reader to accompany textbooks for upper division coursework, the fourteen chapters in this volume come from articles previously found in the *Journal of Ethnobiology*. The editor highlights contemporary studies in ethnobotany to acquaint the readers with current methods and findings in the field. To this end, the book is organized into four sections, ethnoecology, folk classification, food and medicines, and agriculture, each with a short introduction.

In the first section, ethnoecology is introduced in three chapters as the study of human perceptions and management of ecological phenomena, a discipline with roots in human ecology and cultural ecology. A particularly strong theme in the chapters by Janis Alcorn, Gary Nabhan, and Kat Anderson is the concept of adaptive management. In each of these studies ecological perturbations of plant environments are driven by human needs, but the outcomes for ecological communities as a whole are generally positive. In the language groups studied, new resource use patterns lead to greater richness in biological system diversity at the level of both plants and other organisms, such as birds and mammals.

The folk classification section focuses on the ways that people in different language groups construct vocabularies related to plants, with particular emphasis on critiquing or adding to the approaches of Brent Berlin. In the introduction Cecil Brown presents Berlin's most important ideas, folk classification as basically an *intellectual* exercise of organizing plants into series of hierarchical categories in the Linnean tradition. In the following two chapters, Brian Morris and Nancy Turner question the premise of intellectual rather than utilitarian motivation for the naming of plants in their respective studies of the Chewa in Malawi and Salish language groups. Eugene Hunn and David French find that Sahaptin hunter-gatherers do not organize their plant vocabulary into hierarchical series but coordinate organism names into focused groups or peripherally to similar organisms.

The longest section of the book relates to food and medicines and focuses on human interactions with wild plants. Much ethnobotanical literature is oriented to the study of plants as products that can be used as commodities, for example in the pharmaceutical industry. Contrarily for this book, the authors are more interested in studying the human-plant relationship to illuminate questions of conservation. Paul Minnis looks at famine foods in the desert borderlands between the United States and Mexico and how ethnic conceptions of these plants change as new foods are adopted. Robert Bye examines the ethnoecology of maintaining early-succession plant communities for the production of edible wild greens among the Tarahumara Indians. Eugene Hunn critiques representations in Murdoch's 1967 *Ethnographic Atlas* by presenting examples of female plant-gathering activities in the Columbia Plateau area. Jan Timbrook and Robert Voeks examine the dynamic nature of human interaction with medicinal plants. Timbrook notes how certain plants move into or out of favor with Chumash people as a

result of active cultural exchange with other language groups, and Voeks describes how the African diaspora into Brazil resulted in the use of Yoruba religious deities to inform the medicinal uses of local flora.

The agriculture section deals with the ethnoecology of plant modification and domestication. Gary Nabhan shows how plant domestication is an ongoing process among several aboriginal tribes in the southwestern United States. The maintenance of potato diversity in Peruvian highlands in the face of agricultural modernization leads Stephen Brush to conclude that we cannot conceptualize the Green Revolution simply as the replacement of pre-existing agricultural diversity with new domesticated varieties. George Estabrook employs the concept of invisible technology to explain why fuel-wood choices are specific to certain tasks in central Portugal.

The main criticism of this book stems from its relatively narrow geographic focus. Of the fourteen chapters in the book, ten relate to North American language groups and only two treat groups outside of the Americas. This is unfortunate given the detailed and important coverage in the ethnobotanical literature of diverse groups in Africa, Australia, and Asia. The absence of any discussion on the medicinal knowledge of China is a particularly glaring omission in the section on food and medicines.

The strength of this volume lies in its explicit treatment of hybridized ethnobotanical systems in situations where western influences lead to profound changes in the ways that humans interact with the botanical environment. Ethnic vocabularies and interactions with the plant world are not perceived as static, but as evolving and changing with the needs and experiences of the groups involved in their creation. This approach is useful in conceptualizing how human perceptions of plant resources are changing, and in turn how conservation might best be realized.

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EASTERN SUMBANESE BIRD CLASSIFICATION

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To Oemboe Hina Kapita and to the memory of Louis Onvlee (1893-1986)

ABSTRACT.—In regard to ethnozoological classification, the Austronesian-speaking area of insular Southeast Asia is one of the least documented parts of the world. Dictionaries of the language of eastern Sumba by Kapita (1982) and Onvlee (1984) include over fifty names for kinds of avifauna with glosses in Indonesian (Bahasa Indonesia) and Dutch as well as scientific identifications drawn mostly from fieldwork conducted by the naturalist Dammerman in the 1920s. Combining these data with ethnoornithological information collected by the author in the domain of Rindi, the eastern Sumbanese classification of birds is discussed with regard to nomenclature, internal structure, and its relation to a general ethnozoological taxonomy. On the basis of recent ornithological studies of this part of Indonesia, the association of Sumbanese categories with scientific taxa is also reviewed. Finally, the prominence of certain bird categories in the symbolic idioms of ritual speech, myth, and augury is considered as a factor hypothetically linked with eastern Sumbanese ethnoornithological classification.

Key words: eastern Sumba, Rindi, naming and classification of birds, ethnozoological taxonomy, symbolism.

RESUMEN.—El área de habla austranesia del sudoeste insular de Asia es una de las partes menos documentadas del mundo en relación a la clasifición etnozoológica. Los diccionarios de la lengua Sumbanesa del Este escritos por Kapita (1982) y Onvlee (1984), incluyen alrededor de cincuenta nombres de clases de aves, con términos en indonesio (de Bahasa Indonesia) y holandés, así como también indentificaciones científicas extraídas mayormente del trabajo de campo conducido por el naturalista Dammerman en los años1920s. Combinando estos datos con la información etnoornitológica recopilada por el autor de este artículo en el área de Rindi, la clasificación de pájaros del sumbanés del este es discutida en relación a la nomenclatura, estructura interna, y su relación a una taxonomía etnozoológica general. Sobre la base de recientes estudios ornitológicos en esta parte de Indonesia, también se discute la asociación de categorías sumbanesas con taxa científica. Finalmente, la prominencia de ciertas categorías de pájaros en los términos simbólicos del habla ritual, el mito, y el augurio, es considerada como un factor hipotéticamente conectado con la clasificación etnoornitológica de Sumba del Este.

RÉSUMÉ.—La classification ethnozoologique des Austronésiens de la partie insulaire de l'Asie du sud-est est l'une des moins connues dans le monde. Les dictionnaires de Kapita (1982) et Onvlee (1984) sur le langage du Sumba de l'est contiennent plus de cinquante noms d'espèces aviaires traduits en indonésien et

en hollandais, ainsi que leurs identifications scientifiques, dont la plupart proviennent des travaux effectués par le naturaliste Dammerman dans les années 1920. À partir de ces données et de l'information ethnoornithologique recueillie par l'auteur dans le domaine du Rindi, la nomenclature, la structure interne, ainsi que relation de la classification des oiseaux du Sumba de l'est avec une taxonomie ethnozoologique générale sont examinées. L'association des catégories sumbanaises et des taxa scientifiques est également revue à la lumière de récentes études ornithologiques effectuées dans cette partie de l'Indonésie. Enfin, l'importance de certaines catégories d'oiseaux dans l'expression symbolique du discours rituel, du myth et de l'augure est considérée comme un facteur hypothétiquement relié à la classification ethnoornithologique du Sumba de l'est.

INTRODUCTION

To date no special study has been conducted into ethnozoological classification on the Indonesian island of Sumba. The several Sumbanese languages belong to the Austronesian family and more specifically to a Central Malayo-Polynesian grouping (Blust 1979). As part of general ethnographic research carried out in the eastern Sumbanese domain of Rindi in 1975 and 1976 (see Map 1), I recorded a number of names for bird kinds. Most of these, and some others besides, appear in dictionaries of the main eastern Sumbanese dialect of Kambera compiled by Oemboe Hina Kapita (1982), the principal Sumbanese expert on the culture and languages of the island, and by the late Louis Onvlee (1984), a linguist and Bible translator and the main Western expert on Sumbanese languages. Onvlee conducted research jointly with Kapita between 1926 and 1955.

The objective of this paper is to review all information recorded so far concerning eastern Sumbanese ethnoornithological classification. In view of the common appearance of birds in symbolic idioms, for example in Sumbanese ritual language and myth, this topic is relevant to rather more than questions of ethnotaxonomy and nomenclature. Since Onvlee wrote in Dutch while Kapita's work is in Bahasa Indonesia (the Indonesian national language), a particular purpose is to make these data available to a wider ethnobiological, linguistic, and anthropological audience not familiar with these languages.

Another relevant source, also in Dutch, is the writings of the naturalist K.W. Dammerman (1926a, 1926b). On the basis of research conducted on Sumba between 14 March and 26 May 1925 (Monk et al. 1997:882), Dammerman published 32 bird names in eastern Sumbanese (Kambera) and the same number in the western Sumbanese language of Laura (transcribed by Dammerman as 'Laora'). Dammerman's work is germane not only because he was the first Western scientist to identify ornithological species present on the island, including two Sumbanese endemics, but also because Onvlee, especially, relies heavily on Dammerman (1926a) in defining eastern Sumbanese categories. Onvlee's dictionary thus includes just five scientific names that appear to be drawn from (unspecified) sources other than Dammerman. Although both Onvlee and Kapita significantly extend the list of Sumbanese taxa recorded by Dammerman, one unfortunate result of the two lexicographers' reliance on the early naturalist is that many of the Latin binomials incorporated in their dictionaries are now superseded.

Nevertheless, modern binomials are for the most part readily inferred from a recent comprehensive ornithological study of Sumba and other eastern Indonesian islands by B. Coates and K.D. Bishop (1997).

Another pitfall of the two lexicographers' reliance on Dammerman is of course the possibility that the naturalist was mistaken in associating Sumbanese taxa with particular scientific species and genera. Modern information on bird kinds present on the island, however, supported by information drawn from Onvlee and Kapita, as well as linguistic and ethnographic data compiled by the present author, suggest that Dammerman's identifications, scientific as well as ethnozoological, were largely accurate. In this regard as well, the work of Coates and Bishop (1997) has proven especially useful. In identifying eastern Sumbanese bird taxa I have also been able to draw on information provided by several eastern Sumbanese I questioned in 1999 in Kupang, the provincial capital located in western Timor.[1] With the aid of Coates and Bishop's field guide, the Kupang informants were able to clarify a number of important issues concerning the identity of birds named by Sumbanese terms.

In spite of possible remaining gaps and ambiguities, the data compiled here appear sufficiently complete to analyze eastern Sumbanese bird classification and to establish the general outlines of the system. A point of some relevance in this regard is the comprehensive nature of Onvlee's dictionary. As a student of Sumbanese languages who resided on the island for over 20 years, it cannot easily be assumed that Onvlee would have been unfamiliar with many terms referring to birds, even if he had been unable to identify them scientifically. Also noteworthy is the circumstance that Kapita, although a native Sumbanese and probably better able to draw on a local knowledge of birds, does not record any names that do not also appear in Onvlee's dictionary. In fact, Onvlee's work is slightly more complete. This is not to suggest that further research could not uncover additional names for birds. Indeed, three terms encountered in the course of my own enquiries, in Rindi and among Sumbanese in Kupang (***landu witu***, ***mabihi***, ***rawa kawi***, see Table 1),[2] are not listed by either Onvlee or Kapita, nor can they obviously be accounted for as local variants of terms the two lexicographers do record. Even so, the total of nearly sixty-odd I discuss below (56 plus as many as ten unnumbered productive binomials, which total however includes a number of synonymous usages) compares favourably with the 66 bird names (or 59, if probable synonyms and terms with non-empirical referents are excluded) recorded for the Nage of Flores (Forth 1996, 1999), and the 54 terms recorded for the Nuaulu of Seram (Ellen 1993b). The figure for Nuaulu should be taken in the context of a total of 195 species recorded for the island of Seram (Ellen 1993b:57). The comparable total for Sumba as a whole is 161 (see Appendix 1; cf. Monk et al. 1997:354, who list 103 breeding species for Sumba).[3] In view of environmental differences between eastern Sumba and the more heavily forested and better watered western part of the island, moreover, it can safely be assumed that the number for eastern Sumba is rather lower than this.

However the results of the present enquiry are judged, one may hope that they will be of sufficient interest to spur others to advance the study of eastern Sumbanese ethnozoological classification. Indeed, publishing information on the

ethnology of Sumbanese birds is at present a matter of some urgency. Owing in part to the advance of the Indonesian national language, knowledge of Sumbanese names for natural kinds is reported to be decreasing, especially among younger people. In addition, as a result of increased hunting (nowadays particularly with air rifles), trapping to supply the export trade in cage-birds, and the destruction of natural habitats caused by human population increase, clearing of forests for agriculture and lumber, and modern development efforts, in some cases the species to which the indigenous names refer are themselves probably in decline (see Monk et al. 1997:821-35; Coates and Bishop 1997:39-40).[4]

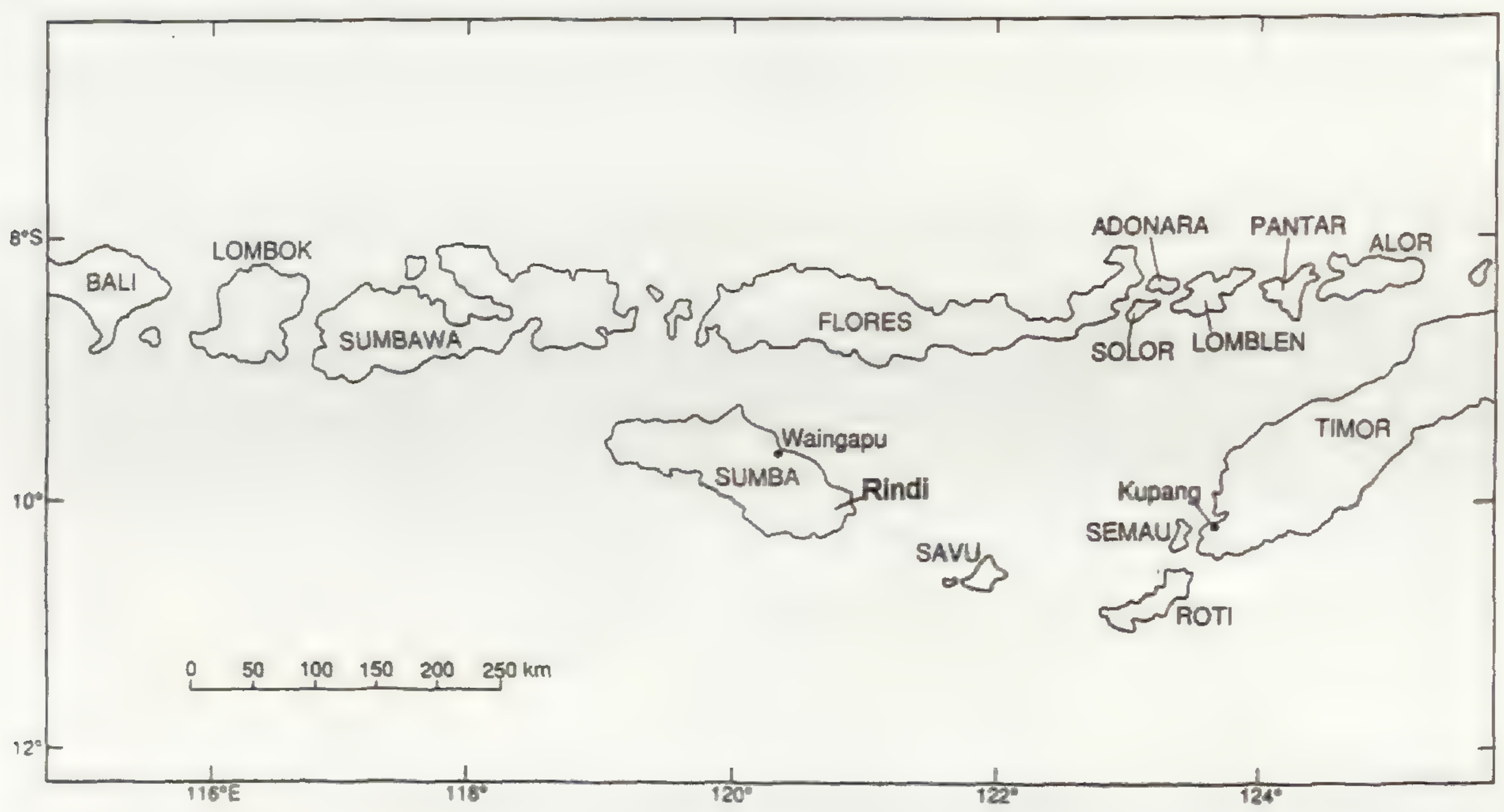

FIGURE 1.— The Lesser Sunda islands showing Sumba and Rindi

BIRDS IN SUMBANESE ETHNOTAXONOMY

The main product of the present exercise is a list of Sumbanese names for birds with provisional identifications. These are set out in Table 1. From linguistic and ethnographic information compiled by the present author in 1975-76, supplemented by Kapita (1982) and Onvlee (1984), it is possible to locate these bird taxa within a broader context of folk taxonomy (see Figure 2). The Sumbanese classification of animal kinds can readily be accommodated to the model of ethnobiological taxonomy developed by Berlin and his associates (see Berlin 1992). Berlin's terms—unique beginner, life-form, intermediate, folk generic, and so on—thus provide a useful means of analyzing local categories and exploring their mutual relationship. The nature of eastern Sumbanese bird nomenclature also lends support to Berlin's approach insofar as it indicates a classification based primarily on observable morphological or behavioural features (including vocal behaviour) rather than on non-perceptual criteria. All the same, the Sumbanese categories are further related in other, non-taxonomic ways, thus participating in a separate, symbolic classification (cf. Forth 1998b:190-91). Non-taxonomic articulations of bird catego-

ries are discussed after a review of nomenclature. In the concluding section I briefly consider the possible influence of symbolic value on the ethnoornithological taxonomy in general.

Whether eastern Sumbanese ethnozoological classification incorporates a term comprehensively designating 'animal(s)'—thus a named "unique beginner" (Berlin 1992:15)—is somewhat debatable. The main candidate is the expression ***makayidi-yàdaku***, 'things that move,' which both Onvlee and Kapita further gloss as 'the whole of creation' (or 'all creatures,' ***semua makhluk***, Kapita 1982 s.v. ***kayidiku***). The phrase is based on the compound ***yidi-yàda***, comprising two roughly synonymous terms meaning 'to move,' and producing an alliterative sound symbolism comparable to English 'topsy-turvy' or 'twist (and) turn' and Bahasa Indonesia ***gerak gerik***, which indeed translates the Sumbanese pair. In combination the affixes ***ka-*** and ***-ku*** lend a repetitive or continuous quality to the basic verbal compound, while ***ma-*** ('that, what, that which') renders the nominal sense. Although logically ***makayidi-yàdaku*** could include *Homo sapiens*, the phrase is not normally applied to human beings and is thus comparable, for example, to the vernacular English use of 'animal,' where the word contrasts with 'man, human.' The main qualification concerns the collective sense of the Sumbanese phrase, that is, the fact that it appears mostly to be used as a reference to 'animals' in general rather than to single individuals. Consistent with this, Kapita does not gloss ***makayidi-yàdaku*** as ***binatang*** ('animal,' Bahasa Indonesia), nor does Onvlee translate it with Dutch ***dier*** or ***beest***. (Also, the last author gives the phrase as ***da makayidi-yàdaku***, thus incorporating the plural article ***da***.) Nevertheless, ***makayidi-yàdaku*** is a term Sumbanese regularly employ to refer to animals, not an expression constructed in response to lexicographical questioning. That they possess a category of 'animal', moreover, is indicated by the numeral classifier ***ngiu*** (tail), which is used when ennumerating animals but not humans or other living things.[5]

Although ***makayidi-yàdaku*** applies to all non-human animals, its focus appears to be undomesticated kinds. Interestingly, ***yàda***, the root of ***yàdaku***, can mean 'wild, untamed, difficult to tame,' as well as 'to move, be capable of movement' (Onvlee, Kapita s.v. ***yàda***). Yet this sense—probably involving a metonymy whereby a propensity to movement connotes the opposite of tameness—is not clearly decisive for its incorporation in the longer expression.[6] Domestic animals are collectively called ***banda***. This however is a secondary meaning of a word, the main sense of which is 'goods, possessions, wealth' (cf. Bahasa Indonesia ***benda***). As this derivation may suggest, the term moreover refers particularly to large livestock, a principal form of wealth in the Sumbanese traditional economy. Some of my Rindi informants claimed that ***banda*** could be understood in the wider sense of 'animal' (Bahasa Indonesia ***binatang***), with wild animals then being specified as ***banda matàmba*** (wild banda); but neither Onvlee nor Kapita record the latter phrase and I suspect that, even at present, it is not a widespread or standard usage. Whatever the case, and regardless of the extent to which ***makayidi-yàdaku*** and ***banda*** may share common referents, the two categories are not obviously related by taxonomic inclusion. By the same token, ***banda*** can be characterized as a utilitarian category, referring mostly if not entirely to a class of economic values,

while ***makayidi-yàdaku*** is a descriptive phrase naming a category of living things distinguished explicitly on behavioural, and implicitly on morphological, grounds.

Since ***makayidi-yàdaku*** refers to an ability to move, it is significant that the taxon subsumes two major categories both of which are denoted by phrases referring to specific kinds of movement. Both constitute "life-form" taxa, in the sense defined by Brown (1979) and Berlin (1992:15ff). One is **mabei**, 'things that creep, crawl,' a large and internally diverse taxon that can include insects, arachnids, reptiles, amphibians, and even fish. The other is ***mahawurungu***, 'things that fly.' Not surprisingly, birds are focal to ***mahawurungu***. Contrary to what the name would suggest, not every sort of aerial creature is included in the taxon. For example, the 'Flying dragon' (probably *Draco volans*, cf. Dammerman 1926a:218, in Rindi called ***kumbu lai hawurungu***, 'flying lizard') is reckoned not to belong to the ***mahawurungu*** but rather to the ***mabei***, together with other lizards. Some Rindi thought that flying insects—such as houseflies, wasps, and bees—should be counted as ***mahawurungu***. However, because they crawl as well, the creatures are also—and probably more usually—classified as ***mabei***. It almost goes without saying that bats are classified as ***mahawurungu***. Since the term translates exactly as 'flying things' it may be questioned whether Sumbanese, like most folk zoologists, actually classify bats as kinds of 'birds.' That they do so is indicated by the fact that Rindi mentioned bats with birds when listing names of 'flying things,' as well as by a local belief that bats lay eggs.

The derivation of ***mahawurungu*** requires comment. ***Hawurungu*** (to fly) comprises a fused prefix, ***ha-***, and ***wurungu***, evidently a cognate of Malay (or Bahasa Indonesia) ***burung*** (bird) and, following some authors, a reflex of an Austronesian protoform referring to birds in general (see Dempwolff 1938; Lopez n.d., cited in Wurm and Wilson 1975). The same sources give no indication that ***wurungu*** reflects protoforms meaning 'to fly,' and it may therefore be supposed that the Sumbanese word derives from a term that once denoted birds but has since, and with the addition of the prefix ***ha-***, acquired a verbal sense which, by way of further prefixing, has as it were reverted to its original meaning.[7] There is however an alternative interpretation. Both Kapita and Onvlee indicate a derivation of ***hawurungu*** (to fly) from ***wuru***, denoting the sound produced by the wings of a flying bird, or by an object that is thrown into the air. In that case, the eastern Sumbanese word for 'to fly' may even be based on an onomatopoeia, and its resemblance with ***burung*** (bird) may be coincidental.[8]

Connected with the opposed modes of locomotion to which the terms refer, ***mahawurungu*** and ***mabei*** comprise creatures that typically occupy areas located respectively above and below the human domain. Indeed, it is partly in this regard that one can comprehend the inclusion of fish (***iyangu***) among the ***mabei***. For although fish do not actually 'creep' or 'crawl,' living in water they inhabit a region beneath the space inhabited by humans. In addition, fish resemble other ***mabei***, particularly reptiles, in several obvious morphological respects, thus suggesting a switch from behavioural criteria as a basis of classification.[9] Although they constitute two major named life-form taxa within the ***makayidi-yàdaku*** (moving things), ***mabei*** and ***mahawurungu*** obviously do not exhaust the Sumbanese category of 'animals.' Most noticeably excluded are mammals, both wild and domesticated.

These are designated only by individual terms (for example, ***ruha*** 'deer;' ***buti*** 'monkey;' ***ringu*** 'dugong') which in most cases refer to terminal taxa coinciding with scientific species. The only distinction made within these categories concerns wild and domesticated varieties of what are considered single mammalian kinds. Thus, the wild cat and wild swine are called ***meo rumba*** and ***wei rumba*** (***rumba*** is 'grass, bush') while their domestic counterparts are usually referred to simply as ***meo*** (cat) and ***wei*** (pig). As can be seen from Table 1, something similar is done when distinguishing wild and domestic kinds of fowls (***manu***) and ducks (***rendi***).

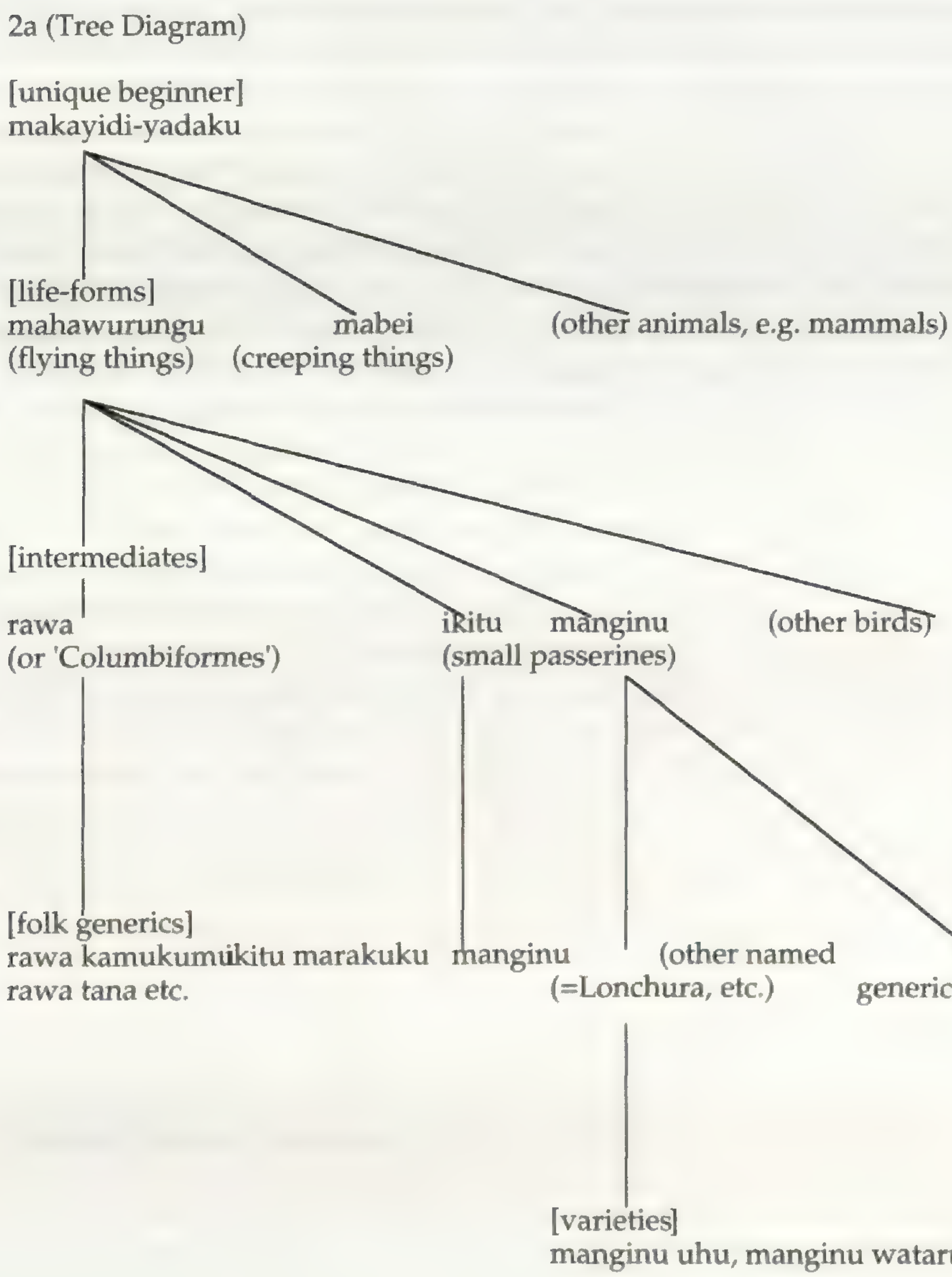

FIGURE 2.—Bird taxa in eastern Sumbanese ethnozoological classification

Since Sumbanese are quite clear that all birds are instances of ***makayidi-yàdaku***, this category and ***mahawurungu*** are unambiguously related by taxonomic inclusion (see Figure 2). For the most part, the 'bird' taxon immediately includes a series of terminal generic taxa (using "generic" in the sense proposed by Berlin 1992:53-53) that are not further divided into named sub-types or varieties. The resulting structure of three levels is of course quite typical of folk classifications of living things.

At the same time, the names recorded in Table 1 include some 28 binomials, and of these 16 appear to be productive in the sense that the second component specifies the referent as an instance of the class labelled by the first term. Thus, ***rawa tana***, for example, specifies a member of the more inclusive category ***rawa***. Other binomials are unproductive. Several comprise two words describing a feature of the bird (e.g., ***katua wei, laleba nggangga, landu witu, mbera wurungu***). The name ***totoru laka*** is also descriptive, combining a probable instance of onomatopoeia with a colour term (***laka***, see Table 1). The six names that include ***kulu-***, while formally similar to productive binomials, are not actually productive. Despite the probable connection between ***kulu-*** and words in other Austronesian languages that mean 'bird' or a kind of bird (e.g., Nage/central Flores ***kolo*** 'dove' [Forth 1996:106]), the Sumbanese term does not denote any particular class of bird.[10] As can be seen from Table 1, the birds thus named are quite various, and indeed, Rindi denied that they were related to one another, or were variants of a single kind. What is more, ***kulu-*** also occurs as a component of terms designating natural kinds other than birds (see ***kulu-kengu***, millipede; ***kulu-nderi***, a kind of grass; see also ***kulungu***, a small sort of mouse and ***kulu***, a kind of breadfruit, *Artocarpus communis* [Onvlee 1984]). In this respect, the morpheme is reminiscent of central Flores (Nage, Ngadha) ***kaka***, which similarly forms part of bird names but further occurs in terms for other natural kinds (regarding Nage, see Forth 1996:101; also Verheijen 1963 on the same element in Manggarai).

Most productive binomials form pairs, thus distinguishing just two taxa within the more inclusive kind (e.g., ***rendi manu*** and ***rendi yalangu***). By far the most prominent instance of productive binomials are the six terms denoting kinds of ***rawa***, all of which refer to members of the Columbidae (pigeons and doves). Not all members of this family, however, are specified with compounds of ***rawa***. Others, particularly it seems smaller members, are named ***kulu-ndiha*** or ***mbàra***, a word that is itself modified to produce terms distinguishing different kinds of dove (see ***mbàra manu*** and ***mbàra nggela***). None of the available evidence indicates that either ***mbàra*** or ***kulu-ndiha*** is straightforwardly included within a broader taxon labelled ***rawa***. At the same time, some of the referents of ***rawa***, applying at the folk generic level, may overlap with those of ***mbàra***. Onvlee thus gives *Treron teysmanni* as the referent of both ***mbàra*** and ***rawa ratu***. (Kapita's gloss, by contrast, links only *Streptopelia chinensis* with ***mbàra***, whereas Onvlee, rather surprisingly, connects this species with no Sumbanese term.) Onvlee further equates ***rawa kakoruku*** with *Geopelia maugei*, while in Rindi this small dove is a probable referent of ***mbàra nggela***.

The terms ***rawa*** and ***mbàra*** are also comparable insofar as both are used without qualification to refer to particular kinds further named by compounds. For example, ***rawa*** refers especially to *Ducula aenea* (***rawa kamukumu***), the Imperial

pigeon, a bird that in Rindi at least is further called ***rawa manu*** and is the largest of the Sumbanese Columbiformes.[11] The appearance of ***mbàra*** in compound expressions denoting creatures that damage ripening rice crops (see Table 2) strongly suggests that this term specifies *Streptopelia* and *Geopelia,* although the cuckoo-dove (*Macropygia ruficeps*) also consumes rice (Coates and Bishop 1997). Larger pigeons, including both the genera *Ducula* and *Treron,* are by contrast fruit-eaters. Hence, it is conceivable that Sumbanese apply ***rawa*** generally to Columbiformes while reserving ***mbàra*** for particular instances, distinguished either absolutely or situationally, according to their dietary behaviour—a matter that bears on an obvious utilitarian or practical consideration.

Whatever the exact relation between ***rawa*** and ***mbàra,*** the former term can be seen as labelling an "intermediate" grouping, falling between the levels of life-form taxa and folk genera (Berlin 1992:139-160; see Figure 2). On the other hand, this status might more accurately be assigned to a larger, unnamed class of Columbiformes, most of which—but not all—are designated as ***rawa*** while others are called ***mbàra*** (or by terms including these) or ***kulu-ndiha***. In other words, all Columbiformes may be treated as a single, distinct—though strictly-speaking covert—intermediate category in eastern Sumbanese ethnoornithological taxonomy (cf. Forth 1996). Another candidate for intermediate status is a group comprising most or all of the diurnal raptors. As noted in Table 1, Falconiformes are generally labelled as ***ikitu,*** although the term's primary referent appears to be the Brahminy kite, a bird more specifically named as ***ikitu marakuku*** ('White necked/throated ikitu'). Consistent with this broader use of ***ikitu*** are three western Sumbanese (Laura) terms for diurnal raptors listed by Dammerman (1926a), all of which include the cognate ***wikita***. These are ***wikita liza, wikita rewa koko,*** and ***wikita labo,*** and correspond respectively to eastern Sumbanese ***kapàha, ikitu/ikitu marakuku,*** and ***mbaku/mbaku tehiku***.

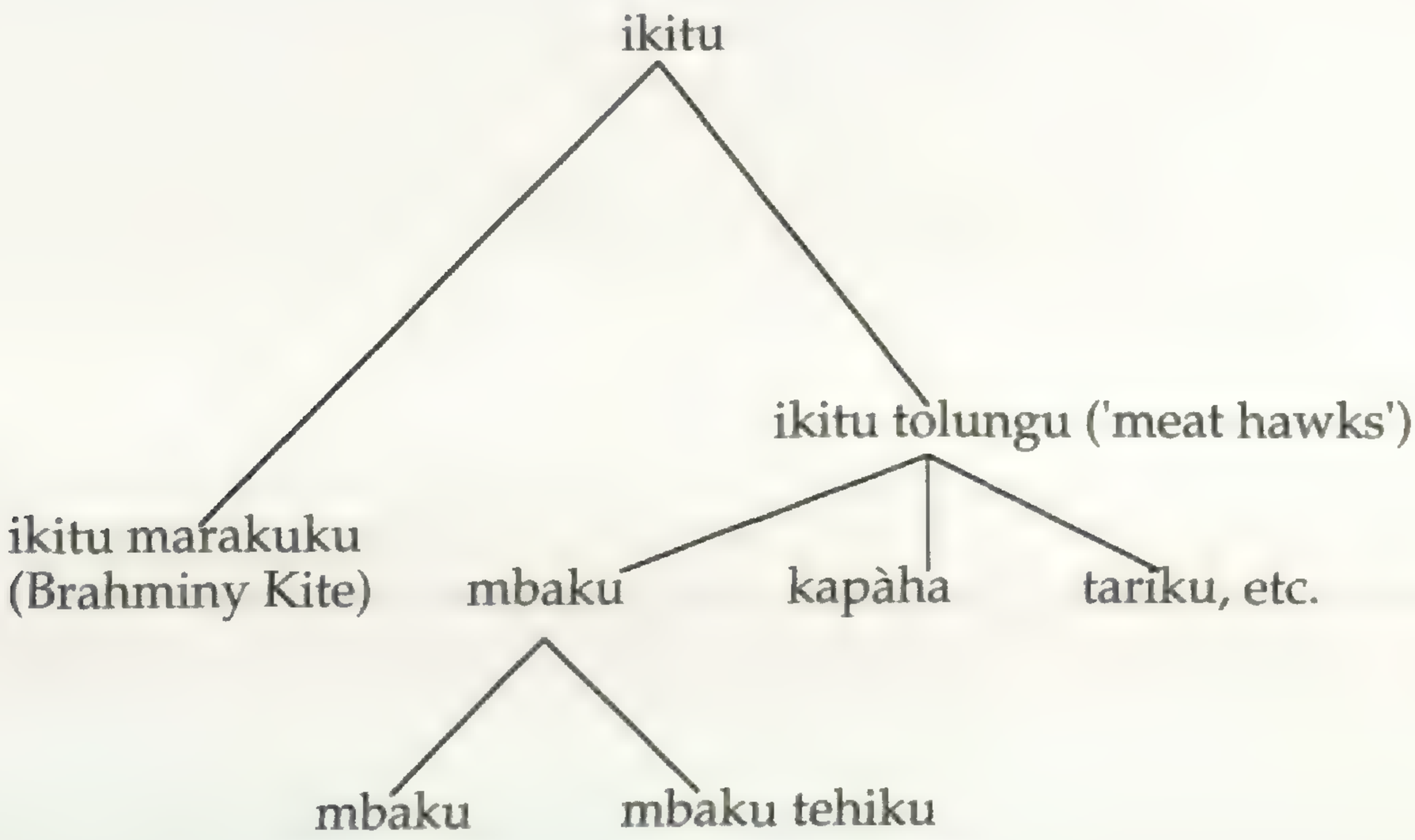

FIGURE 3.—A Rindi classification of diurnal raptors (**ikitu**)

According to the detailed report of a Rindi informant, ***ikitu***, understood as a general term for diurnal raptors, comprises two divisions. One includes a single kind, the Brahminy kite (***marakuku***). The second, labelled as ***ikitu tolungu*** (roughly, 'meat hawks'), admits other named kinds (***kapàha***, ***mbaku***, ***tariku***; see Table 1), including members of both the Accipitridae and the Falconidae (see Figure 3).[12] The same source specified the following order of size among members of the second division: ***mbaku tehiku*** (*Haliaeetus leucogaster*, the largest), ***mbaku***, ***kapàha***, ***tariku*** (the smallest).[13] Unfortunately, I was unable to determine how far this classification of diurnal birds of prey is shared among eastern Sumbanese. Essentially, it separates the Brahminy kite (*Haliastur indus*), the raptor most closely associated with the name ***ikitu***, from all other members of the broader taxon identified with the same term. Since *Haliastur indus* also eats flesh, the contrasting term 'meat hawk' does not illuminate the basis of the division. It is however possible that the bird's greater reliance on scavenging rather than killing may be relevant.[14] Also, while the Brahminy kite is often sighted inland—where, like other raptors, it is perceived by Sumbanese as a threat to poultry—it is more commonly found on the coast. This of course is also the preferred haunt of the sea-eagle (***mbaku*** or ***mbaku tehiku***). But the sea-eagle is nevertheless distinguished from the kite insofar as, according to Rindi at least, the former is the one raptor that does not steal chickens.[15]

As elsewhere in Indonesia, on Sumba large raptors play a prominent role in creation mythology. In parts of Flores, it is the Brahminy kite in particular that is associated with a creator deity (Laubscher 1975; see also Freeman 1960 and Metcalf 1976, regarding the Brahminy kite in Bornean cosmology and augury). In eastern Sumba, by contrast, this part is taken by *Haliaeetus leucogaster*, the White-bellied sea-eagle (see below). Yet Rindi descriptions of the mythical bird sometimes suggested features of the Brahminy kite. Relevant to a possible conflation of the two birds which this suggests is Onvlee's gloss, which indicates that the large kite may be classified as a kind of ***mbaku***, more particularly the 'White-throated ***mbaku***' (***mbaku bara kuku***, see Table 1), a situation that recalls the sort of classificatory overlap already evidenced with regard to Columbiformes. Effecting an inversion of the relation of inclusion implied by Onvlee, my Rindi informant listed both ***mbaku*** and ***mbaku tehiku*** under ***ikitu tolungu***. However, his description of members of the first taxon (***mbaku***) did not unambiguously indicate the Brahminy kite, and it may well be that, in Rindi at any rate, this term is applied to a variety of larger eagles and hawks. Regional variation in folk classification may be relevant in resolving these issues. So too may colour phases and environmental contexts of large raptors. For example, *Haliastur indus* (the Brahminy kite) may be classified as a kind of ***mbaku*** specifically when encountered near the sea (cf. Ellen 1993a).

Another folk taxon represented as comprising a number of distinct types is ***manginu***. Like Onvlee (1984), Rindi informants claimed there were numerous 'kinds' (Bahasa Indonesia ***macam***, ***jenis***) of ***manginu***.[16] Mentioned among these were ***manginu uhu*** ('rice manginu'), ***manginu wataru*** ('maize manginu'), ***manginu tana*** ('ground [-dwelling] manginu'), and ***manginu kulu-kataitaku***; but there were reckoned to be many more besides, whose names were not known. With the exception of ***kulu-kataitaku***, a term used alone to label a generic taxon (see also

manginu kadu, Table 1), these several qualifiers however suggest simple descriptors serving merely to distinguish varieties of a single basic kind. In its most focal sense, ***manginu*** denotes Estrildine finches, especially munias (genus *Lonchura*) and similar small birds that do damage to rice and other cereal crops. Thus, the compound ***mbàra manginu***, 'doves and munias,' is a standard expression for birds that destroy ripening cereals. Yet in a more inclusive application the term further refers to a large variety of generally small passerine birds (or "dicky-birds"; see Figure 2), in which context it suggests an intermediate grouping comparable to ***ikitu*** and ***rawa*** (cf. the Nage term ***peti***, ***ana peti***, Forth 1996, which is similarly paired with a term for Columbiformes, ***kolo***, to refer to crop pests).[17] At the same time, in its more inclusive sense ***manginu*** differs from these insofar as it appears not to be simultaneously identified with a single, undivided folk generic (as exemplified by ***ikitu marakuku*** and ***rawa kamukumu***). This broader usage of ***manginu*** would moreover account for the apparent absence from the eastern Sumbanese ethnoornithological lexicon of special (that is, folk generic) terms for small birds such as flowerpeckers, flycatchers, honeyeaters, sunbirds, titmice, wagtails, warblers, white-eyes, and whistlers (see Appendix 1).[18] Apart from the focal finches and other small birds designated by special names, I would estimate that as many as 25 species listed in Appendix 1 could be classified simply as ***manginu***.

Eastern Sumbanese categories include two other candidates for intermediate status. One is an implicit taxon comprising the two black birds named ***nggangga*** (Large-billed crow) and ***laleba nggangga*** (a drongo, probably the Wallacean drongo). That these form a set is suggested not only by their physical resemblance, particularly in regard to colour, but by the designation of one as the 'sister's child' (***laleba***) of the other (regarding the use of kin terms as evidence of covert intermediate taxa, see Berlin 1992:145). The other instance of a possible intermediate taxon is ***panii***. Usages recorded by Onvlee indicate that this term serves both to name the Flying fox and as a label for a more inclusive class that also includes much smaller bats (e.g., those called ***pahomba*** in Rindi). By contrast, evidence from Rindi suggests that ***panii*** may there refer only to Flying foxes (*Pteropus* spp.) while smaller members of the Cheiroptera may consistently be named with other terms.

NOMENCLATURE

As mentioned above, several names comprising two lexemes refer to empirical or reputed characteristics of the birds so named (e.g., ***katua wei***), as do components of productive binomials (e.g., ***ikitu marakuku***). Where the meaning of a name, or part of a name, is analyzable, this is indicated in Table 1. The six names comprising ***kulu-*** all have analyzable second elements. Of these, four refer to visible features (e.g., ***-kadu***, 'horn, horn-coloured'); one is onomatopoeic (***-kawàki***); while the other possibly refers to some general quality attributed to the bird (***-ndiha***, 'good, attractive'). In contrast, among names constituted of single lexemes, only two—***kola*** and ***mbaku***—possesses an independent meaning that describes a morphological or behavioural feature of its avifaunal referent. Another possibility is ***nggokaria*** (heron), insofar as this may be a variant of ***nggokaru***, 'to stretch, crane the neck,' which Onvlee further lists as the word for 'heron' in the Lewa dialect of eastern Sumba. (Alternatively, ***nggokaria*** may comprise two ele-

ments, ***nggoka*** and ***ria***, the first of which recalls central Flores ***gako***, 'large heron;' see Nage ***gako tasi***, Forth 1996.) ***Laleba nggangga*** indirectly refers to a morphological feature insofar as it alludes to a resemblance with the Large-billed crow, ***nggangga***. By the same token, it is the only name that includes a kin term (***laleba***, 'sister's child'). (***Ana*** in ***ananjàki*** cannot be construed as 'child' in the sense of a relationship term.) About 17 of the names in Table 1 describe physical features of their referents. Others refer to environmental associations (see ***landu witu***, ***mbaku tehiku***, ***rawa tana***).

Only a minority of names—about seven—are locally recognized as wholly or partly onomatopoeic (***koka***, ***kui***, ***kulu-kawàki***, ***nggangga***, ***rawa kamukumu***, ***rawa kakoruku***, ***tutuku***). Judging from reported vocalizations, another eight are possible onomatopoeia (see ***kahuhu***, ***kahiku***, ***kaluki***, ***kutuku***, ***kuu***, ***pipi***, ***pirihu***, ***totoru laka***). The large number of avifaunal names beginning with ***ka-***, a fused prefix, reflects a general lexical feature of Sumbanese languages. However, in some cases (notably ***kamukumu*** and ***kakoruku***, but see also, e.g., ***kahiku***, ***kahuhu***) the prefix specifies something producing a sound denoted by the root (***mukumu***, ***koru***; see Table 1). In other instances, the fused suffix ***-ku*** appears to effect a similar result (see ***kutuku***, ***tutuku***). The resemblance between ***nggokaria*** and ***nggonggali*** is probably superficial.[19]

Of the nearly sixty terms listed in Table 1, 33 or about 60 per cent, appear to name single scientific species. A large majority of these are the single representatives of their genera present on Sumba. If Dammerman and the lexicographers are accurate, a further three probably refer to just two members of the same genera (***ananjàki***, ***kalewaru***, ***powa***). Eight names, including three designating taxa of intermediate status, apparently refer to three or more species of the same genera or indeed two or more genera (***ikitu***, ***karata***, ***manginu***, ***mbàra***, ***mbera wurungu***, ***nggokaria***, ***pipi***, ***rawa***). In the remaining cases, information is insufficient to make a determination.

How far names for folk generic and intermediate taxa are further applied, or "extended" (Ellen 1993b), to species and higher order groupings associated with scientific kinds listed in Table 1 cannot be decided without more research into Sumbanese knowledge of birds. There are, for example, five species of *Hirundo* (see ***mbera wurungu***) on Sumba, numerous members of the Ardeidae (including *Ardea*, *Egretta*, and representatives of six other genera; see ***nggokaria***), and at least eight species of the Scolopacidae (sandpipers, snipes and allies; see ***pipi***, ***kahuhu***). Yet one cannot know a priori how many members of these ornithological families and genera Sumbanese would regularly identify with the indigenous terms. It is similarly unclear whether less common Columbiformes (such as the White-throated pigeon, Little cuckoo-dove, Nicobar pigeon, and two species of *Ptilinopus*, or fruit-doves) would be classified as ***rawa*** or named with other, thus far unrecorded, terms. In accordance with the classification illustrated in Figure 3, it is a reasonable surmise that ***ikitu*** can be applied without further qualification to Falconiformes, including five members of the Accipitridae recorded on Sumba but not indicated as possible referents of terms listed in Table 1. In regard to size, these are either comparable to the Brahminy kite (***ikitu marakuku***) or White-bellied sea-eagle (***mbaku tehiku***, the largest Sumbanese raptor) or fall somewhere between the two.

These sorts of questions of course turn partly on the completeness of the bird names listed in Table 1, an issue addressed earlier. As suggested, it is probable that a large number of small passerine species are simply classified as ***manginu***. Comparative evidence supports this. For example, Ellen, writing on the Nuaulu of Seram, refers to an "under-differentiation of passerines" that is "quite astonishing" (1993b:79). (A more general "under-differentiation of avifauna", or classificatory "lumping", Ellen partly attributes to migration and straggling.) Given that eastern Sumbanese are not a maritime people, one should also not be surprised that seabirds and species inhabiting coastal environments are not particularly well represented in Table 1.[20] Larger passerine birds recorded on Sumba which are not obviously identifiable with known indigenous terms, but which one might expect to be separately named, include bee-eaters, cuckoos, cuckoo-shrikes, and the dollarbird (see Appendix 1). Yet even some of these could conceivably be named by employing already attested categories. Smaller cuckoos, for example, could be classified with the koel (***kutuku***), as might the larger Channel-billed cuckoo (*Scythrops novaehollandiae*), while bee-eaters and other larger passerines are arguably not so large that they could not be included in the category ***manginu***.[21] A comparable case are small kingfishers (Alcedinidae), if these are not classified with the significantly larger Halycyonidae as ***kahiku***. (Also not to be ignored is the fact that Sumbanese has a single life-form label—***mahawurungu***—that can simply be applied to identify any bird not further classifiable.) In marked contrast, the names listed in Table 1 include no fewer than five terms referring to parrots (***kaka, kàriku, katàla, pirihu, wowangu***). Not only do all of these apparently denote single scientific species, but the five kinds exhaust parrot species occurring on Sumba. Thus, even though they do not compose a distinct intermediate grouping—or at least not one that is named—the Sumbanese Psittacidae are nevertheless taxonomically elaborated to an even greater degree than diurnal raptors (***ikitu***) and Columbiformes (***rawa***).

TABLE 1.—Eastern Sumbanese bird names

1. ***ananjàki*** (or ***ana njàki***). One or more species of *Anthus* (D 12: *Anthus rufulus*). Two present on Sumba include *A. novaeseelandiae* (Richard's pipit) and *A. gustavi* (Pechora pipit). As in other eastern Indonesian languages ***ana***, 'child', can also denote a small version or instance of something (cf. Nage ***ana go***, probably *A. novaeseelandiae*, Forth 1996). ***Njàki*** apparently has no independent meaning.
2. ***ikitu*** *Haliastur indus intermedius*, Brahminy kite (D 30, *Haliastur intermedius*). In Rindi the term refers more generally to Falconiformes. Kapita glosses it as BI ***elang*** ('hawk') and 'Palconidae' (sic).
   ikitu marakuku. Also a reference to *H.indus*. ***Marakuku*** means 'white-neck(ed), throat(-ed).' The bird is also called by this term alone.
3. ***kahiku***. *Halcyon chloris* (D 19). The only other *Halcyon* kingfisher present on Sumba is *H. australasia* (C&B). Whether the Sumbanese term might also refer to other kingfishers is not known. In view of one cry of *H. chloris* reproduced as '***kick kyew***' (C&B), the name, particularly the root ***hiku***, is probably onomatopoeic.
4. ***kahuhu***. A small shorebird, sandpiper. Kapita identifies the bird with the species Dammerman lists for ***pipi*** (see below). The word is probably unrelated to ***huhu*** in the sense of 'breast, milk' and is possibly onomatopoeic (see '***teu-hu-hu***', the call of the Common redshank, *Tringa totanus*, C&B).

5. ***kaka***. *Cacatua sulphurea citrinocristata*, Yellow-crested cockatoo (D 24: *Cacatua citrinocristata*). Onvlee also lists ***kaka ratu***, or 'royal cockatoo', as a reference to a cockatoo 'with red eyes', but this appears not to refer to a separate species.
6. ***kalewaru***. *Collocalia* spp. (D 18), swiftlets. Species occurring on Sumba include the Edible-nest swiftlet, *C. fuciphaga*, and the Glossy swiflet, *C. esculenta*. Nests of the former species are collected for sale and eventual export. The local name ***kalewaru*** (cf. Manggarai ***lawar***, 'swiftlets and swallows', Verheijen 1963) is related to BI *kelawar* or *kelelawar*, referring to a small bat. It is therefore of some interest that both swiftlets and bats characteristically roost in caves, often the same caves. Onvlee glosses the almost identical name ***kaliwaru*** as 'swallow' and, referring to Dammerman (D 17), as *Hirundo*. Dammerman in fact gives only ***mbera wurungu*** (see below) as the eastern Sumbanese name for swallows, though for western Sumba he lists the cognate ***kalewara*** for both *Hirundo* and *Collocalia*.
7. ***kaluki***. *Megapodius reinwardt reinwardt* (D 38: *Megapodius duperreyi*), Reinwardt's scrubfowl. The name plausibly imitates part of the bird's call, given by C&B as ***'kli-au-kau'*** (see ***wundu***, below).
8. ***kapàha***. A small falcon, kestrel (D 29: *Cerchneis occidentalis*). Following C & B and the descriptions given by Dammerman (1926a:214, 1926b:22), the term is likely to include *Falco moluccensis*, the Moluccan kestrel or Spotted kestrel. (Another small falcon is *F. longipennis*, the Australian hobby, but this has only once been recorded on Sumba.) Kapita similarly describes the bird as a small Falconiforme with speckled plumage. Whether the name is related to ***pàhangu*** (=***pàha*** + ***-ngu***), meaning 'to drop (trans.), let drop', is not indicated by the lexicographers.
9. ***kapi padangu***. Recorded in Rindi, the term does not appear in either Onvlee or Kapita. ***Kapi*** means 'to flicker (of a light or fire)'; ***padangu*** is 'plain, pasture.' In view of ***kapi mama***, 'firefly', the term possibly refers to an insect rather than a bird.
10. ***kapiru***. Described by Onvlee as a "small red bird, a ground thrush" (Dutch *grondlijster*) which lays eggs in "a hole in the ground". Kapita's gloss "Pittadae" (sic) indicates a pitta. Although not actually in holes, Pittas in general do nest on or near the ground (C&B). The only pitta recorded on Sumba is *Pitta elegans maria*, the Elegant pitta, which has a red belly and vent and is described as "locally common or moderately common" on Sumba (C&B). Kapita's further gloss, *kutilang*, an Indonesian (BI) name for a kind of bulbul (none of which are natural to Sumba), can probably be ignored.
11. ***karata***. Terns (Laridae, sub-family Sterninae), probably including the Gull-billed tern, *Gelochelidon nilotica*, and one or more species of *Chlidonias* and *Sterna*. Rindi informants stated there were two kinds of ***karata*** but could not distinguish them by name. A similar account was given by a Kupang informant, who described a 'pure white' variety that occurs near inland lakes and paddy fields and another sort, cream-coloured with dark marks on the back of the head, which is found on the coast. Onvlee and Kapita appear mistaken in identifying ***karata*** with, respectively, gulls (Dutch *zeemeeuw*) and Jaegers (BI ***burung camar***). There are no gulls (Larinae) on Sumba.
12. ***kàriku***. *Eclectus roratus cornelia* (D 26: *Eclectus cornelia*), the Eclectus parrot. Rindi distinguish red and green varieties (***kàriku rara*** and ***kàriku muru***). As Dammerman (1926a:213-14) notes, these are actually the female and male of the same species, a fact recognized by Rindi people as well.
13. ***katàla***. *Tanygnathus megalorynchos sumbensis* (D 27), Great-billed parrot.
14. ***katua wei***. The name means 'companion of the pig.' Kapita further glosses it as 'pig spirit' (BI ***roh babi***). Both he and Onvlee identify this as an owl whose call indicates the presence of wild pigs, a notion encountered elsewhere in Indonesia (Forth 1998b). Information is insufficient to determine whether ***katua wei*** refers to a

particular species of owl or whether this is one of the Strigidae or the Tytonidae (cf. ***wàngi*** below). Among the Strigidae, C&B report just one, unidentified, member of the genus *Otus* on Sumba, as well as *Ninox rudolfi*, the endemic Sumba boobook. Quite possibly, ***katua wei*** denotes one or more varieties of nocturnal sound, rather than a particular kind of visible owl.

15. ***koka***. *Philemon buceroides neglectus* (D 11; not cited by Onvlee), the Helmeted friarbird, the only *Philemon* species present on Sumba. The name, also rendered contextually as ***nggauka***, is described as onomatopoeic.
16. ***kola***. A diurnal raptor, listed by Onvlee as *'Astur torquatus'*, distinguished by a 'neck ring of feathers' (cf. Latin 'torquatus', 'wearing a twisted collar or necklace'). The name probably derives from ***kola*** in the sense of 'speckled, flecked.' Kapita glosses the term as 'falcon, Peregrine falcon' (BI ***alap-alap***; *Falco peregrinus*).
17. ***kuu***. Both Onvlee and Kapita identify this as a kind of kite (Dutch *bastaard-wouw*) and specifically as 'Elanus hypoleucos', an apparent reference to the Black-winged kite, *Elanus caeruleus hypoleucos*. Neither the name nor the bird is listed by Dammerman. As Onvlee notes, the call of this bird, usually heard in the evening, is considered inauspicious. In Rindi, it is more particularly regarded as a manifestation of a witch. Consistent with this association are the partly crepuscular habits of *Elanus caeruleus* (C&B 1997:247), since Sumbanese witches, too, are believed to be especially active at twilight. On the other hand, Rindi described ***kuu*** as a 'black', or dark coloured, bird, as did informants in Kupang. That this does not entirely accord with the plumage of the Black-winged kite may be explained by the bird's nocturnal associations; indeed on this account Kupang informants claimed never to have clearly seen the bird. Alternatively, ***kuu*** might refer to another bird altogether. In Umalulu, a domain immediately to the north of Rindi, I was shown a photograph of a dead bird identified as a ***kuu*** which had been killed because of its inauspicious calling after dark and which, I recall, resembled a female koel (see ***kutuku***, below). Kruyt (1922:559), apparently inaccurately, describes ***kuu*** (transcribed as 'koeoe') as another name for the owl otherwise called ***wàngi*** (see below). He also characterizes the name as onomatopoeic, as did one Kupang informant. Noteworthy here is the arguable resemblance of ***kuu*** to a nocturnal call of the koel ('***kooeei*** or ***ko-el***', C&B). However, another cry of the bird, rendered by Kupang informants as 'yeep' or 'weep', corresponds with vocalizations reported by C&B for the kite, *Elanus caeruleus*.
18. ***kui***. A bird named after its call (Onvlee), but otherwise unidentified. Kapita describes it as having green plumage and feeding on ripe mangoes and other fruits. If this description is accurate, a likely candidate is the glossy green Short-tailed starling, *Aplonis minor*, which is reported as 'moderately common' on Sumba (C&B p. 468) and consumes fruit (see also Mason and Jarvis, 1989:47, regarding the papaya-eating habit of Balinese *Aplonis panayensis*). (Contrary to Forth 1981:113, ***kui*** seems not to be associated with witches. This idea apparently reflects confusion with ***kuu*** [see above].)
19. ***kulu-kadu***. *Saxicola caprata* (D 9: *Pratincola caprata*), Pied bushchat (or Pied Chat, C&B). ***Kadu***, 'horn', alludes to the largely black plumage of the male. A term mentioned by Kupang informants, ***manita watu*** (***watu*** is stone, cf. BI ***batu***), is possibly a dialectal name for the bushchat (cf. BI ***kucita batu***).
20. ***kulu-kakuta***. *Oriolus chinensis broderipii* (D 14: *Oriolus broderipi*), Black-naped oriole. Meaning 'resembling betel (***kuta***),' ***kakuta*** seems to refer to the bird's appearance, although its plumage is predominantly yellow and black.
21. ***kulu-kanuhu***. *Terpsiphone paradisi sumbaensis* (D 16: *Terpsiphone sumbaensis*), Asian paradise-flycatcher. ***Kanuhu***, which refers to the horse colour called Isabella, may describe the male bird's predominantly off-white plumage. Onvlee, however, further

glosses the term as 'rolled combed cotton', which recalls the bird's exceptionally long tail feathers. A Rindi myth recounts how these were derived from strands of cotton.

22. ***kulu-kawàki***. A rail. Given by Onvlee as *Rallina fasciata* (Red-legged crake), but this species has not been recorded on Sumba (C&B). In respect of its attributed vocalizations, the bird is possibly *Gallirallus philippensis*, the Buff-banded rail, or *Amaurornis phoenicurus*, the White-breasted Waterhen. The second element of the name is onomatopoeic (Kapita). Reputed to be especially vocal just before the onset of the southwest monsoon, the bird is significant in Rindi as an index of seasonal change.

23. ***kulu-ndiha***. A sort of pigeon (Kapita: BI ***merpati***, ***burung dara***, both general terms for 'pigeon, dove'). The term is at least partly, and perhaps exclusively, applied to domestic pigeons. Onvlee gives as western Sumbanese equivalents ***rawa*** and ***rawa tana*** (see below). Dammerman (D 35) gives ***kuru ndasi*** (cf. Nage ***kolo dhasi***, Domestic pigeon, Forth 1996:106) for 'Turtur tigrinus', or 'turtle dove', referring apparently to *Streptopelia chinensis* (*tigrina* is the name of the sub-species of *S. chinensis* found in Wallacea; see ***mbara***). The term ***kuru ndasi*** is not found in either Onvlee or Kapita. The second element of ***kulu-ndiha*** possibly derives from ***ndiha*** in the sense of 'good, attractive.'

24. ***kulu-taitaku*** or ***kulu-kataitaku*** or ***manginu kulu-kataitaku***. Recorded in Rindi. Not listed by Onvlee or Kapita, though Onvlee gives ***manginu taitaku*** (see below). Onvlee glosses ***taitaku*** as 'to walk, run quickly' (cf. Kapita who provides the same gloss for ***kataitaku***), and describes ***manginu taitaku*** as a bird that moves by jumping. The most likely referent is *Rhipidura rufifrons sumbensis*, the Rufous fantail. This is supported by Dammerman (1926a:210, 1926b:79), who gives the Laura (western Sumbanese) name for *'Rhipidura semicollaris'* (*semicollaris* is the name now given to the sub-species of R. rufifrons that occurs on Flores) as ***kela kataga***, 'dancing bird', a term evidently cognate with ***kulu-kataitaku***.

25. ***kutuku***. *Eudynamys cyanocephala*, Australian koel (D 21: *Eudynamis everetti*). According to C&B, this is the only member of the genus occurring on Sumba. The Common koel, *E. scolopacea*, is not listed by these authors, who however note that it may be conspecific with *E. cyanocephala* (1997:353). A possible application of the term ***kuu*** to the koel was noted above (see entry no. 17). Since the suffix ***-ku*** can indicate reduplication, the name ***kutuku*** is conceivably explained as a reference to a bird that calls ***'kutu kutu'*** (cf. ***tutuku***, below).

26. ***laleba nggangga***. Kupang informants identified this bird as a drongo. It is most probably the Wallacean drongo, *Dicrurus densus*. The name literally means 'sister's child of the crow (***nggangga***).' Accordingly, Rindi describe ***laleba nggangga*** as like a crow only smaller. Onvlee (s.v. ***nggangga***), citing Dammerman, lists the term as a reference to a 'small black bird' which he identifies as *Corvus enca*. However, C. *enca* does not occur on Sumba; nor in fact does Dammerman (1926a:208) link this species—which can hardly be called 'small'—with the Sumbanese name.

27. ***landu witu***. From illustrations, Kupang informants identified this as a species of nightjar, probably *Caprimulgus affinus*. Their descriptions of the bird's appearance and habits also support this identification. The term is translateable as 'sign of (from) the long grass' (see Onvlee, s.v. *landu*, which also means 'crest'). The name does not appear in either Kapita or Onvlee. According to Kupang informants, the distinctive nocturnal cry of a nightjar, reproduced as 'cheri-ki-ki-ki', indicates the presence of a thief, an idea that may illuminate the sense of 'sign' (***landu***) in the bird's name.

28. ***mabihi***. Unidentified. An eastern Sumbanese name reported only by Kupang informants, who gave quite various accounts of the bird's appearance. The name is not found in Onvlee or Kapita. The variant in the dialect of Mangili is ***mabahi***.

29. ***manginu***. Small birds, kinds of Munia (D 13; cf. *Lonchura*). The focus of the Sumbanese category comprises several of the Estrildine finches, especially ones that

do damage to crops (see the Dutch name *rijstdiefjes'* [Dammerman, Onvlee], 'little rice thieves'). C&B record six species on Sumba, including four munias (*Lonchura molucca, L. punctulata, L. quinticolor, L. pallida*), the Red avadavat (*Amandava amandava*), and the Zebra finch (*Taeniopygia guttata*). The names of other small birds classified as ***manginu*** are qualified, as follows.

manginu kadu. A black, horn-coloured ***manginu*** 'which however does not eat rice' (Onvlee). Very probably another name for ***kulu-kadu*** (see above).

manginu kani. *Passer montanus*, Tree sparrow (Kupang informant; ***kani***, or ***uhu kani***, is the cereal *Panicum viride*). According to C& B, the species was first recorded on Sumba in the 1940s.

manginu taitaku (see ***kulu-taitaku***, above)

30. ***manu***. *Gallus gallus*, Domestic fowl; distinguished from ***manu tata*** (below) as ***manu mopu***, 'tame fowl.' Several varieties are distinguished according to colour, size or derivation.
31. ***manu tata***. *Gallus varius* (D 37), Green junglefowl, sometimes simply called ***tata*** (cf. Nage ***kata***).
32. ***mbaku***. *Haliaeetus leucogaster*, White-bellied sea-eagle (D 31: *Haliaetus leucocephalus*). Probably further applied to other large eagles and hawks. ***Mbaku*** also means 'to float, soar, glide, hover' (Onvlee; see also ***luku mbaku***, 'mbaku river', as the name of the Milky Way).

mbaku bara kuku. Described by Onvlee as an eagle with a white neck, smaller than the sea-eagle (***mbaku***), and otherwise 'orange' in colour. This however describes the Brahminy kite (see above: ***ikitu, ikitu marakuku***. ***Marakuku*** is synonymous with ***bara kuku***).

mbaku tehiku. Given by Onvlee as 'large sea-eagle', the designation appears to be merely a more elaborate name for *Haliaeetus leucogaster*. On the other hand, it could conceivably include another large coastal raptor, the osprey (*Pandion haliaeetus*), which is intermediate in size between the larger sea-eagle and the Brahminy kite. ***Tehiku*** is 'sea.'

33. ***mbàra***. A dove. According to Kapita, my own field notes, and identifications provided by Kupang informants, the term denotes *Streptopelia chinensis*, the Spotted dove, and possibly also *Geopelia maugei* (but see ***rawa kakoruku***, below). Following Dammerman, Onvlee associates the name with *Treron teysmannii* (D 32: *Osmotreron teysmanni*), the endemic Sumba green pigeon. However, partly in view of Onvlee's further identification of the scientific name with ***rawa ratu***, this appears mistaken.

mbàra manu. A larger kind of ***mbàra***, the size of a domestic fowl (***manu***; Onvlee s.v. ***mbàra***). The term was also recorded in Rindi, where it probably specifies *Streptopelia chinensis*.

mbàra nggela In Rindi, a smaller kind of ***mbàra***, possibly *Geopelia maugei*. Onvlee (s.v. ***ngguku, nggela***) describes ***mbàra nggela*** as a dove smaller than a similar kind called ***ngguku nggela*** (see below). Both of the latter terms mean 'to move up and down, to nod' and refer to the Columbiforme habit of bobbing the head. Kapita and Onvlee further gloss ***ngguku*** as 'to coo.' In Sumbanese songs and narratives, the call of the ***mbàra*** is rendered as ***turu tu tu*** (Wielenga 1909).

34. ***mbera wurungu***. Swallows, *Hirundo* spp. (D 17). The name translates as 'broken fragment of a pot' (Onvlee, Kapita) and thus is evidently not related to ***hawurungu*** in the sense of 'to fly.' It is a reasonable surmise that ***mbera wurungu*** is further applied to Wood swallows (*Artamus leucorynchus*) and swifts (*Apus* spp.; see Appendix 1), but this cannot be known from the available sources.
35. ***nggaha***. Domestic goose (recently introduced). From BI ***angsa*** (goose).
36. ***nggangga***. *Corvus macrorhynchos* (D 8), Large-billed crow. Like its many cognates in Austronesian languages, the name is locally recognized as onomatopoeic.

37. ***nggokaria***. Herons, *Ardea* spp. (D 40). The term probably also refers to Egrets (*Egretta* spp.) and other members of the Ardeidae. Rindi informants stated there were two kinds of ***nggokaria*** but did not know names for these. A Kupang informant suggested that Australian pelicans (*Pelecanus conspicillatus*), occasional visitors to Sumbanese inland lakes, might be classified as ***nggokaria***. Probably relevant here is their watery habitat, as well as the white and black plumage, shape of their heads and—as the informant himself pointed out—large bills.
38. ***nggonggali.*** *Rhyticeros everetti* (D 20: *Rhytidoceros everetti*), Sumba hornbill. The species is a Sumbanese endemic.
39. ***ngguku, ngguku nggela***. Apparently the same bird otherwise designated as ***mbàra*** or ***mbàra nggela*** (see above). In Rindi, ***ngguku nggela***, which refers to Columbiformes' habit of head-bobbing, was a war cry uttered periodically by victorious warriors, particularly it seems when returning to their village with enemy heads, and while preparing the heads for ritual use (see Kruyt 1922:561). A Kupang informant from the eastern Sumbanese domain of Lewa reported the name ***ngguku kulungu***, which he identified from illustrations in C&B as *Geopelia maugei* (see ***mbàra***).
40. ***pipi***. One or more kinds of sandpiper (*Tringa* spp.; D 41: *Tringoides hypoleucus*). Dammerman's reference particularly suggests *Actitis hypoleucos*, the Common sandpiper, whose call C&B describe as 'a piping *tii-tee-tee*' (C&B). Onvlee and Kapita give the equivalent term in the Mangili dialect of eastern Sumba as ***ahu ramuku***, 'pool dog' (***ramuku*** is 'pool, pond, wallow'). ***Pipi*** may be synonymous or overlap with ***kahuhu*** (see above).
41. ***pirihu***. *Trichoglossus haematodus* (D 23), Rainbow lorikeet. The endemic Sumbanese sub-species is *T. h. fortis*. The name bears some resemblance to one of its calls, reproduced by C&B as *'peaow, peaow, peow'*, and so is possibly onomatopoeic.
42. ***powa***. *Coturnix* spp., quails (Onvlee). Two species occur on Sumba, *C. ypsilophora pallidior* and *C. chinensis*, the Brown quail and Blue-breasted (or Chinese) quail. Whether the term also applies to buttonquails (Turnicidae), two species of which (including one endemic) occur on Sumba, is not known.
43. ***rawa, rawa kamukumu.*** *Ducula aenea* (D 33: *Carpophaga aenea*), Green imperial pigeon. Dammerman's description clearly fits *D. aenea*. The Sumbanese sub-species is *D. a. polia*. As both Onvlee and Kapita note, the bird is also simply denoted by the generic term ***rawa***, thus indicating that the species is the focus of the Sumbanese category. ***Kamukumu*** is onomatopoeic.
44. ***rawa kakoruku***. *Geopelia maugei* (D 36), Barred dove (Onvlee). Kapita associates this term with BI ***perkutut***, which McKinnon (1991), referring to Jawa and Bali, identifies as *Geopelia striata*. Rindi claim that if this bird calls at night it presages a death. The second element of the name is onomatopoeic (cf. ***koru***, 'to coo (of a dove)'; ***ka-*** and ***-ku*** are fused affixes).
45. ***rawa kawi***. A kind of pigeon, otherwise unidentified. The name was recorded only in Rindi. Informants were unable to explain ***kawi***, a word appearing in neither Onvlee nor Kapita, though they described ***rawa kawi*** as intermediate in size between ***rawa manu*** (see below)—the largest ***rawa***—and ***rawa tana***.
46. ***rawa manu***. A kind of large pigeon, about the size of a domestic fowl (***manu***). The name was recorded in Rindi, where informants' descriptions suggested it may be a local designation for the bird otherwise known as ***rawa kamukumu*** (*Ducula aenea*).
47. ***rawa ratu.*** *Treron teysmannii*, Sumba green pigeon (following Onvlee, who cites D 32, probably in regard to the western Sumbanese name 'rawa ratoe'; cf. ***mbàra*** above). The species is a Sumbanese endemic. ***Ratu*** refers to a high-ranking ceremonial leader. In view of its use in similar contexts (see e.g. ***ularu ratu***, the Reticulated python; also ***kaka ratu*** under ***kaka*** above), the term probably alludes to the bird's colourful plumage.

48. ***rawa tana.*** *Chalcophaps indica* (D 34), Emerald dove. In Rindi I was told that the bird is so named because it remains on or close to the ground (***tana***, also 'land, earth, soil') and never alights in trees. It is also described as silent or rarely vocal, unlike all other ***rawa***. (This notion may derive from the circumstance that *C. indica* usually does not call when on the ground; see C&B 1997:316.) Owing to its reputedly quiet nature and iridescent green plumage, in ritual language the bird's name symbolizes favourable qualities and spiritual beneficence.
49. ***rendi.*** *Anas* spp. (D 42), ducks. Wild ducks and introduced, domestic varieties are distinguished respectively as ***rendi matàmba*** and ***rendi mopu***, 'tame ducks.' According to Onvlee, domestic varieties are further distinguished with reference to their origins, as for example ***rendi jawa*** and ***rendi manila***. The most common species of wild duck, according to Dammerman, is *Anas superciliosa*, the Pacific black duck. According to C&B, the only other species of Anatidae found regularly on Sumba is *Anas gibberifrons*, the Sunda teal. However, a member of the Dendrocygnidae, *Dendrocygna arcuata*, the Wandering whistling-duck, is also present and locally common.

rendi manu. Recorded in Rindi. A kind of wild duck (***manu***, 'domestic fowl')

rendi yalangu. Recorded in Rindi. A kind of wild duck, smaller than ***rendi manu***. ***Yalangu*** is evidently a different word from **yàlangu**, which Onvlee records as the name of a kind of eucalyptus tree (*Melaleuca leucadendron*).

50. ***tariku***. A kind of falcon or small kite (Onvlee, Kapita); otherwise unidentified. An apparent synonym is ***taripu***.
51. ***totoru laka.*** *Centropus bengalensis*, Lesser coucal (D 22: Centropus javanicus). This is the only coucal that occurs on Sumba. The first part of the name is probably onomatopoeic (cf. 'totok, totok, totopuk, totopuk, totopuk' C&B). ***Laka***, denoting a red colour and a tree, the leaves of which are used to produce a red nail varnish, evidently refers to the bird's rufous wings. ***Totoru laka*** does not appear in Kapita.
52. ***tutuku***. The name of the coucal given by Kupang informants (cf. ***totoru laka***), who explained it as deriving from an imitation of its the bird's call, rendered as 'tutu tutu.' The fused suffix ***-ku*** indicates repetition of the preceding element. ***Tutuku***, however, is not listed as the name of a bird by either Onvlee or Kapita. In view of the relatively close relation and similarity of size, form, and colour between coucals and koels (***kutuku***, see above), the phonological and morphological resemblance of the names ***tutuku*** and ***kutuku*** is a point of some interest. Another is names for the Lesser coucal in dialects of the Manggarai language of western Flores, where it is called ***kotok*** or ***totok*** (Verheijen 1963).
53. ***wàngi.*** *Tyto alba sumbaensis*, Barn owl (D 28: Dutch *kerkuil, Strix flammea.*) Another Sumbanese species of *Tyto* is *T. longimembris*, the Eastern grass owl. Dammerman states that the bird is considered to manifest a punitive spirit, and that its 'croaking' or 'cawing' forebodes sickness or death. Rindi people associate ***wàngi*** with witches and particularly with the spiritual essence of a witch, called ***wàndi***. A connection between this term and ***wàngi*** is however improbable (see Forth 1991:109 n6, 445). A more likely cognate of the bird's name is ***suangi***, a word that in Malay and other western Indonesian languages refers to a maleficent, nocturnal spirit (cf. eastern Indonesian Malay ***suangi*** or ***suanggi***, 'witch'). A Kupang informant described ***wàngi*** as designating all owls 'that are seen', thus implicitly contrasting the term with ***katua wei*** (see above). Even if this is correct, however, the available evidence still points to *Tyto alba* as the focus of ***wàngi***.
54. ***wowangu.*** *Geoffroyus geoffroyi floresianus* (D 25: *Geoffroyus floresianus*), Red-cheeked parrot.
55. ***wundu.*** A synonym of ***kaluki*** (see above)

56. ***yàpi***. *Gallinula* spp. (D 39: *Gallinula frontata;* Onvlee, incorrectly citing Dammerman, gives *'Gallinula phunicura'*). Two species of *Gallinula* occur on Sumba, *G. tenebrosa* and *G. chloropus*, the Dusky moorhen and Common moorhen. For Sumbanese the bird's most distinctive feature is the bright red bill, which appears in both species. Another red-billed water bird that occurs on the island is *Porphyrio porphyrio*, the Purple swamphen. From illustrations, Kupang informants identified both the latter and *G. tenebrosa* as ***yàpi***. Onvlee describes the bird as inhabiting paddy-fields and doing damage to rice and tubers.

ADDENDUM: BATS

pahomba. A small bat (possibly *Tylonycteris* sp.), about the size of a swallow or large butterfly. The creatures are said to roost in the tops of banana trunks where, Rindi claim, they lay eggs about the size of a dove's. Apparently referring to the same small bat, Onvlee (s.v. ***pani***=Kapita's ***panii***) lists the terms ***pani ru_kalu*** ('banana leaf bat') and ***pani palinju wiki*** ('bat that fouls itself'). Sometimes ***pahomba*** bats enter houses. In Rindi, they are considered a manifestation of spirits associated with clan shrines, also called ***pahomba***. Being mystically powerful, the creatures are also able to assume human form.
panii (***pani***, Onvlee). Flying fox (Pteropus spp., following Dammerman). The term also means 'to talk, speak', and probably alludes to chattering noises made by large fruit-bats. Rindi people reported two kinds which they distinguished only as 'large' and 'small' (***panii bokulu***, ***panii kudu***). These may correspond to the two species recorded by Dammerman (1926b:22) as *'Pteropus morio'* (*P. alecto morio*?), described as almost entirely black, and *'Pteropus gilvus'* (Dobsonia *peronii*?), which is yellow-brown in colour (see Forth 1998a, regarding two kinds of Flying fox distinguished by the Nage of central Flores). On the other hand, the reference may be to Flying foxes and much smaller bats respectively, especially in view of indications that ***panii*** also serves as a general term for bats (see ***pahomba*** above).
panyonga makaweda. Recorded in Rindi. A small bat. The name means 'tricks, fools elderly people.'

KEY:

Onvlee=Onvlee 1984, Kapita=Kapita 1982.

BI=Bahasa Indonesia, the Malay-based national language.

C&B=Coates and Bishop 1997.

D=Dammerman 1926a except where otherwise indicated.

Numerals after 'D' indicate numbers assigned to species identified by Dammerman (1926a). Latin names given by Dammerman, many of which are now superseded, are not italicized. Where only a number is given with 'D', the scientific name provided by Dammerman coincides with the one recognized at present.

'Kupang informant(s)' refers to Sumbanese consulted in Kupang, the capital of Nusa Tenggara Timur province, in 1999.

SYMBOLIC ASSOCIATION AND METAPHORICAL PAIRING

Especially the composition of life-form taxa (named with reference to modes of locomotion), and of apparent intermediate taxa, indicate that eastern Sumbanese ethnozoological classification is primarily based on morphological and behavioural criteria. At the same time, several categories of birds are linked in non-taxonomic ways that may generally be called symbolic. Several ethnoornithological categories are paired in the parallelistic idiom of ritual language. For example, the conjoined phrases ***pirihu pauli, kaka makanguhuru***, 'assembled parrots, collected cockatoos,' refers to any large group of people who unite to expedite a ritual or some other customary undertaking. A number of pairings are listed in Table 2. Together these include 13—thus nearly a quarter—of the categories appearing in Table 1.

Although the list is meant to be illustrative rather than exhaustive, a glance at Table 2 suggests that the three names associated with intermediate taxa (***ikitu, manginu, rawa***) are particularly salient in ritual speech. It may be no coincidence, moreover, that the most prominent of these, ***rawa***, a term that pairs with at least four others (including plant and insect categories), is the focus of one of the most elaborate areas of eastern Sumbanese ethnoornithological classification. The most frequently named bird in ritual idioms is in fact the domestic fowl (***manu***). ***Manu***, however, is mostly coupled with ***wei***, denoting the domestic pig, and the reference is then to the value of both as domesticates, sacrificial victims, and (with

TABLE 2.—Bird names included in ritual speech couplets

manu//**rendi**, domestic fowl//duck

manu//**wei**, domestic fowl//(domestic) pig

mbàra//**manginu**, dove//munia (or 'small seed-eating bird')*

nggangga//**ikitu**, crow//hawk (or specifically, Brahminy kite)

nggauka//**rawa**, friarbird (=**koka**)//pigeon

pirihu//**kaka**, lorikeet//cockatoo

rawa//**moha**, pigeon//**moha** tree (unidentified)

rawa//**ngginggi**, pigeon//spider

rawa//**ngguku**, pigeon (Imperial pigeon)//dove

rawa tana//**ngginggi rara**, Emerald dove//red spider

tariku//**ikitu**, falcon//hawk (or specifically, Brahminy kite)

*As a general reference to crop pests, these two terms are simply compounded. In the same context, they are further conjoined with the pair **kulungu kalau**, 'small mice and rats.'

regard to their intestines and livers respectively) as auguries revealing the will of ancestral spirits. The pairing of ***rawa*** and ***nggauka***—a ritual language substitute for ***koka*** (friarbird)—evidently reflects the association of these two birds in creation mythology (see below), in which context the first term refers specifically to the Imperial pigeon (***rawa kamukumu***).[22] By contrast, in one pair of phrases linking ***rawa*** with ***ngginggi*** (spider), the former is specified as ***rawa tana***, the name of the Emerald dove (*Chalcophaps indica*), which is then more exactly paired with ***ngginggi rara*** (red spider), denoting a particular non-poisonous arachnid. In yet another pairing ***ngginggi*** is specifically linked with ***rawa muru***, 'green pigeon,' which, though not a standard ethnoornithological term, probably also refers to the Emerald dove. On the other hand, in the expression ***pakamu rawangu, pakameli mohangu***, 'cooing like a pigeon, trembling like leaves of the ***moha*** tree' (a reference to spirits of the dead, Onvlee s.v. ***rawa***), the Columbiforme in question is evidently the Imperial pigeon, since it is specified as making the sound ***kamu*** (=***kamukumu***).

Where Sumbanese ritual speech conjoins two bird categories, the names generally denote kinds that are morphologically or behaviourally similar. For example, Rindi explain the pairing of 'duck' and 'domestic fowl' (***rendi*** and ***manu***) with reference to their characteristically large broods. In fact, the only obvious exception is the pair ***rawa*** and ***koka***. Expressions featuring the couplet ***ikitu*** / / ***tariku*** associate the two Falconiformes with contrasting environments—land and sea, or earth and sky. Yet the metaphorical import of these expressions turns less on the opposing environmental associations than the identical predatory habits of the two raptors. Indeed, since it is ***tariku*** rather than ***ikitu*** (a term most closely linked with the Brahminy kite) which is linked with the sea, the environmental associations are contrary to ornithological fact. A similar complementarity of dry land and water is also implicit in the ritual speech coupling of domestic fowls and ducks, though in this case of course the environmental contrast is valid.[23]

Most of the ethnoornithological terms included in Table 2 designate kinds which are also prominent in Sumbanese myth. Among these are the Imperial pigeon (***rawa, rawa kamukumu***) and the friarbird (***koka***), who dispute over the length of day and night and the mortality of mankind (Forth 1992). Especially important in creation mythology is the White-bellied sea-eagle (***mbaku***). In parallel form named as i Mbongu i Mbaku (***mbongu***, 'mist, dew;' ***mbaku***, 'to float, glide, hover'), the sea-eagle flaps his great wings causing the waters of the primeval flood to subside and the dry land—specifically the island of Sumba—to appear. Also mentioned in myths of creation are the crow (***nggangga***), cockatoo (***kaka***), and fantail (in Rindi called ***kulu-kataitaku*** or ***manginu kulu-taitaku***), as well as a spider (***ngginggi***), a non-ornithological taxon which, interestingly enough, also appears in Table 2. The three bird kinds figure as well in an origin myth of the Rindi clan Kanatangu, which further recounts how various species acquired their characteristic plumage. Other birds appearing in this narrative include the oriole (***kulu-kakuta***), Asian paradise-flycatcher (***kulu-kanuhu***), Eclectus parrot (***kàriku***), and Spotted dove (***mbàra***). Several narratives recorded by Wielenga (1909)—mostly fables featuring animal kinds—similarly feature three Columbiformes (***mbàra, rawa***, and a pigeon identified as 'kuru ndiha,' cf. ***kulu-ndiha***), three parrots (***kaka, kàriku, pirihu***), the crow, the friarbird, the junglefowl (***manu tata***; see also Wielenga

1913), a heron (***nggokaria***), and 'small birds' (***manginu***). In the mythological genre called **analalu**—or 'orphan' tales—a dove, specified as ***mbàra***, sometimes appears as a messenger who, in a song, reveals the identity and relates the tribulations of an orphaned hero.[24] From these several traditions, it can be seen how mythically significant avifauna—including a large raptor, Columbiformes, and small birds classified as ***manginu***—coincide to a significant degree with kinds composing hypothetical intermediate taxa, just as do the bird categories of parallelistic ritual speech. Also noteworthy in this regard are the several parrots and bird kinds whose names include the component ***kulu-*** (although, as demonstrated, ***kulu-*** does not actually label a divided taxon, nor for that matter a class of any kind).

Another symbolic value attaching to several bird kinds concerns their significance as omens. The augural value of the owl called ***katua wei***, whose cry is thought to reveal the presence of wild pigs (see Table 1), of course pertains to hunting. Vocalizations of the kingfisher (***kahiku***) heard near a settlement indicate to Rindi that a thief is about. A similar significance is attributed to the distinctive nocturnal cry of the nightjar (***landu witu***, see Table 1). The cries of two other birds are especially ominous because Sumbanese regard them as manifestations of witches. Variously described as birds 'ridden by' witches or as physical forms taken by the malevolent spirit (***wàndi***) of a witch, these are the Large-billed crow (***nggangga***) and the bird called ***kuu*** (provisionally identified as the Black-winged kite, see Table 1; Forth 1981:113; Kruyt 1922:559). If either of these birds calls near a house where someone is ill, then it is a sign that the illness is caused by a witch, and that the person will likely die. By the same token, a large flock of crows is a more generally negative portent. The owl called ***wàngi*** is also considered an embodiment of a witch's ***wàndi*** (see Table 1 regarding the resemblance between these two terms), an idea that possibly illuminates the common belief that if an owl alights on a papaya tree, the tree will die.[25] Because of their association with witches, one should not verbally abuse or throw stones at crows, owls, or the ***kuu***. Nevertheless, it is permitted to kill a ***kuu*** if it makes too much noise after dark.

According to Kruyt (1922:558-9), the cries or behaviour of several birds were formerly significant in the context of warfare and headhunting. An outgoing war party would rejoice if they encountered crows (***nggangga***) cawing. However, if they came across crows perched silently, this was considered an ill omen, and the party should return home. It was similarly inauspicious if either a crow or a bird of prey (***ikitu***) flew across the path of a group of warriors, as this would portend casualties and defeat. On the other hand, if birds of either kind followed a war party, then they could be confident of success. If a ***rawa***—which from Kruyt's description appears to refer to an Imperial pigeon (***rawa kamukumu***)—was heard calling in a village at night, this indicated that an enemy was preparing to attack. Similarly, if a ***mbàra*** (glossed by Kruyt as 'wood pigeon') called in the evening or early in the morning—something the bird does not usually do—then people should not to leave their homes the following day. Were they to do so, they would suffer some (unspecified) loss. Kruyt adds that nocturnal vocalizations of the ***mbàra*** might alternatively indicate the presence of thieves in the vicinity, as might the nocturnal screech of an ***ikitu*** (diurnal raptor). In Rindi I encountered a similar belief concerning the Columbiforme identified as ***rawa kakoruku*** (see Table 1, nos. 43, 33, s.v. ***mbàra***), whose nocturnal cry can presage a death. Although the interpreta-

tion cannot be fully developed here, it seems there may be a more general connection between Columbiformes—particularly ones designated as ***ngguku*** and ***nggela*** (see Table 1, s.v. ***mbàra***, ***ngguku***)—and headhunting. Apart from the fact that they commonly fall victim to birds of prey, this could be motivated by their apparently flexible necks, evidenced by their habit of bobbing their heads up and down, and the relative disattachment of head and body which this might suggest.[26]

Among birds whose cries or behaviour Sumbanese consider ominous, the occurrence of neither owls nor the kingfisher has any particular relevance for their taxonomic status: both are simply called by terms occurring at the level of folk genera. On the other hand, Columbiformes and diurnal raptors, thus birds associated with named intermediate taxa, figure quite prominently in this symbolic domain, as they do in myth and ritual speech idioms. Evidently the most ominous bird of all, the Large-billed crow (***nggangga***), moreover, participates in a hypothetical intermediate category together with a similarly dark bird, the drongo (***laleba nggangga***), which, being specified as its 'sister's child,' shares part of its name.

CONCLUSION

Despite the provisional nature of several ornithological identifications of Sumbanese bird taxa given in Table 1, I have argued that the information available here is sufficient to offer a general characterization of their folk classification. Within the entire domain labelled by the term ***makayidi-yàdaku*** (animals), the classification isolates two named life-form categories—'flying things' and 'crawling things.' Members of these two categories are the most strongly contrasted in terms of morphology, behaviour, habitat, and symbolism. Other animals, notably mammals, then figure as a residue of this binary partition. They are, to be sure, ***makayidi-yàdaku***, yet they occupy no separately named or otherwise clearly distinguished grouping within this inclusive class. Relevant here may be the circumstance that there are relatively few mammals, especially large mammals, on Sumba, while those that are present (deer, wild pigs, macaques, several rodents, the palm civet, and a wild cat) are quite various. The most numerous mammalian species are bats, but these of course are classified as—or with—'birds.' In other folk systems, 'fish' sometimes appear as another named life-form taxon (Brown 1979). But while Sumbanese possesses a general term for 'fish' (***iyangu***), and while they have names for over one hundred kinds (Forth 1981:429, note 28), Rindi classify these and other water creatures as instances of ***mabei*** (crawling or creeping things).

Intervening between the life-form taxon ***mahawurungu*** (flying things) and the numerous folk generic taxa, eastern Sumbanese bird classification reveals three or more identifiable "intermediate" classes. Two, which partly at least are identified with the names ***rawa*** and ***ikitu***, respectively comprise Columbiformes and Falconiformes. A third, labelled ***manginu***, includes a variety of small passerine birds that have as their focus several species of Estrildine finches. Remarkable in this regard is the overall resemblance between eastern Sumbanese bird classification and the ethnoornithological classification of the Nage people of central Flores (Forth 1996). Largely from evidence provided by free recall lists, I have previously

shown how Nage ethnotaxonomy implicitly entails several intermediate taxa. Most prominent among these, both in terms of the number of named folk generics they include and the priority usually given to them in free recall, are mostly covert categories coinciding with the scientific groupings labelled 'Falconiformes' and 'Columbiformes.' In addition, the Nage category ***ana peti*** closely parallels Sumbanese ***manginu***, being especially associated with the genus *Lonchura* and related birds of very small size but contextually including many other small kinds besides, even to the extent that ***ana peti*** is sometimes used as a general term for 'bird.' (Nage, it should be noted, have no term exactly corresponding to Sumbanese ***mahawurungu*** which unequivocally includes all birds). Another similarity with Nage concerns the relatively low number of onomatopoeic terms in Sumbanese bird nomenclature, which even including unconfirmed instances amount to no more than 25 per cent of names. For Nage the figure is approximately 30 per cent, which also appears quite low in comparison with some other languages (Forth 1996:103).

Sumbanese treatment of Columbiformes and Falconiformes, especially, bears on another general issue of ethnoornithological classification. Not only are these two groups taxonomically salient; they are equally prominent in the symbolic genres of parallelistic ritual speech, myth, and bird augury. With regard to approaches Berlin (1992:143,149) calls utilitarian or functionalist, as well as his own observation that intermediate taxa may sometimes be grounded in "cultural" as opposed to morphological or behavioural factors, one needs to consider whether these two facts may be related. Relations between symbolism and taxonomy cannot be treated conclusively here, not least of all because it has not been possible to review all data relevant to the Sumbanese valorization of birds. In closing, however, I would register several points.

First, even where named by terms further associated with hypothetical intermediate taxa (e.g., ***rawa***, ***ikitu***), most—perhaps all—symbolically significant birds are actually identifiable with folk generics (e.g., ***rawa tana***, ***ikitu marakuku***), nearly all of which appear to correspond to single scientific species. It is therefore the most basic categories rather than more inclusive ones that possess distinctive symbolic value; hence it cannot be claimed that this sort of value crucially informs intermediate or higher groupings. The use of general names in symbolic contexts even where more specific designations are available might be ascribed to performative requirements of parallelistic language and traditional narrative, both of which favour single lexemes. A similar consideration could apply to standard admonitions regarding omen birds. That is, where a particular member of a divided class has a negative association, it might be thought prudent to extend this to all, empirically similar, members of the same class. It is just conceivable that distinctions may be made within a class in order to deny an omen contextually or to restrict its range absolutely (cf. Bulmer 1968:637-8, regarding a similar interpretation of New Guinean transformation beliefs). This, however, is merely a hypothetical possibility, and there is no obvious indication that such symbolic motivation of class division has been operative in eastern Sumbanese.

A second consideration is that named intermediates are not only mythically, metaphorically, and augurally significant; they possess more pragmatic—functional or utilitarian—kinds of value as well. This should not be surprising, as both

symbolic and utilitarian values attaching to avifauna typically relate, more or less directly, to perceptible physical properties, including the appearance or behaviour of particular birds. With one exception, all diurnal raptors (***ikitu***) thus prey on domestic fowls. Columbiformes, both ***rawa*** and ***mbàra***, are also common victims of raptors, while at the same time, among wild birds, pigeons and doves are especially valued as food, and so fall prey to human hunters as well. ***Mbàra***, or smaller doves, further draw practical attention as crop pests, as do many small birds classified, at the folk generic level, as ***manginu*** (a label further applying to another hypothetical intermediate taxon).[27] It comes as no surprise, therefore, that ***ikitu***, ***rawa***, and ***mbàra*** are categories of Sumbanese bird augury, especially in the context of warfare, and thus in relation to human competition and violent aggression.

As the foregoing should suggest, while various sorts of interest in birds may affect the attention given to particular kinds in folk taxonomy, distinctions manifest in Sumbanese symbolic usage, like those pertaining to utilitarian concerns, are consistent with observable morphological and behavioural differences existing independently of those interests. Where natural kinds differ from or resemble one another in regard to symbolic value or practical utility as well as empirical features, therefore, one cannot readily argue that one of the three sorts of factors is more determinant of their linguistic and cultural recognition than the others. Indeed, it is probable that the three interact in complex ways. Nevertheless, in view of their relative ontological independence, morphological and behavioural considerations are, in the long run, likely to prove the most important. Supporting this in the present case is the fact that the majority of Sumbanese birds are not of any practical value, nor are they symbolically significant.

My final point concerns the very terms of the contrast implicit in the issue of symbolism. Contrary to what is often implied in debates over the relative importance of perceptual versus non-perceptual factors in ethnobiological classification, the symbolism of natural kinds is not necessarily more culturally specific or contingent than is the taxonomic recognition (or mental representation) of salient natural features.[28] This is indicated, for example, by the fact that 'hawks' and 'doves' form a metaphorical contrast in English-speaking cultures as well as in eastern Sumba, and by the extraordinarily widespread conception of owls and crows as birds of ill omen. Again, this undoubtedly stems from objective physical features of the kinds in question. Yet the fact that their metaphorical value (if not their specific interpretations) is cross-cultural attests as much to universal properties of human cognition as it does to the universal availability of physical avifaunal features for symbolic deployment. These observations tend to suggest that "symbolic value" and "psychological salience" are not as distinct or separate as is often supposed. For this reason alone, the question of whether bird symbolism exercises a decisive influence on aspects of ethnotaxonomy, in eastern Sumba or in general, must remain moot.

NOTES

[1] Hereafter designated as 'Kupang informants,' these included Ibu Djukatana, who is a daughter of Oemboe Hina Kapita; her husband, Bapak Drs. Ng. Djukatana (Oemboe Juka Tana); Bapak Minggus Osa and Bapak Thomas Tagudodu, both associated with Nusa Cendana University; Bapak Petrus Yiwa, an Instructor in the Law Faculty at Artha Wacana

University; and several eastern Sumbanese undergraduate students of the latter university. I am most grateful to all of the foregoing for their help, and to Dr. Tom Therik, the Rector of Artha Wacana, who sponsored by visit and kindly assisted me in a variety of ways while in Kupang.

[2] Sumbanese terms are transcribed according to the orthography used by Kapita and Onvlee. Single letters mostly represent sounds similar to their English denotata. The /à/ (see ***ananjàki***, Table 1) variously denotes the schwa or a sound like the /u/ in 'duck.' The /w/ is often closer to English /v/, especially in medial positions (see ***rawa***). The /b/ and /d/ are implosives phonemically contrasting with /mb/ (see ***mbaku***) and /nd/ (see ***kulu-ndiha***). I follow Kapita in employing ii and uu to indicate vowel lengthening (see ***panii*** and ***kuu***), whereas Onvlee places an acute accent above the vowel in question.

[3] From lists provided by Verheijen (1963), dialects of the Manggarai language of western Flores would each appear to possess perhaps as many as 100 names for birds, including a fairly large number of productive binomials. The area however is relatively rich in avifauna; Verheijen's estimate is 180 species, which he claims probably coincide with all those found on Flores island (1963:678). A count of species described in Coates and Bishop (1997) yields a total of 232 for Flores. For the Tobelo of the large Moluccan island of Halmahera, P.M. Taylor (1990) similarly records 111 bird categories, which also include a number of productive binomials.

[4] Reporting on his 1925 visit, Dammerman (1926b:24) remarked how cockatoos were already extinct in the vicinity of Waingapu, eastern Sumba's main port, owing to the large numbers caught for export to Java.

[5] In his Dutch-Kambera wordlist, Onvlee (s.v. *dier*) refers to ***bohu***, a word meaning 'thievish, voracious,' and more specifically to ***mabohu***, which he translates as 'wild animals.' As I know partly from my own experience in Rindi, however, the phrase refers not to wild animals in general but more specifically to relatively large and dangerous animals. Accordingly, Onvlee exemplifies his initial gloss with 'wild pig, snake, crocodile,' while Kapita translates ***bohu*** with Bahasa Indonesia ***buas***, a word that means 'cruel, savage,' and 'wild' only in this restricted sense. Analyzable as 'what is wild (savage, cruel)', ***mabohu*** thus does not of itself necessarily denote animals. For example, ***tau bohu*** denotes a (human) thief.

[6] According to Onvlee, ***yàda*** more specifically refers to a quick movement. He further glosses the word as 'to teem, swarm' and 'to wriggle, fidget.' Similarly, he describes ***yidiku*** as denoting a movement slower than ***yidi***.

[7] An evident borrowing from Malay, ***mburungu*** occurs in compound expressions where it refers specifically to bird figures found, for example, on European coins (Onvlee 1984).

[8] Worth noting here is the form ***wururu***, which also refers to the sound of bird's wings or something being thrown, but further denotes a cry uttered at the beginning, or between segments, of ritual song, including mortuary song (cf. Onvlee 1984; Kapita 1982). When performed, the element ***ru*** is repeated not just twice but numerous times, thus effecting a sort of whirring sound. Whether this is meant to replicate the sound of a bird in flight, or anything else in particular, I was unable to establish from questioning.

[9] Illustrating uses of ***makayidi-yàdaku***, Onvlee (s.v. ***yidi***) records the phrase ***makayidi-yàdaku la wai***, "everything that teems in the water". While evidently including fish, and thus in a sense cross-cutting ***mabei***, the expression differs from the two life-form terms by its inclusion of the term for 'animal(s).'

[10] Fernandez (1996:146) lists the Proto-Flores term for 'bird' as ****kolon***.

[11] The use of ***manu***, 'domestic fowl,' to make distinctions within named ethnobiological categories appears to be quite widespread in eastern Indonesian languages, and not only to apply to birds. For example, among the Nage of central Flores, smaller varieties of the Green tree viper and the Monitor lizard are respectively called ***hiku manu*** and ***ghoa manu*** (Forth 1995:53, 66 n.4). On Sumba and elsewhere ***manu*** further appears in the names of plants, but this is mostly explained by resemblance to parts of domestic fowls. For example, ***pelu manu***, 'wattle (of a fowl),' and ***tara manu***, 'cockspur,' designate respectively a kind of wild grape and a thorny plant.

[12] Two other raptors listed in Table 1, the ***kola*** and ***kuu***, were not mentioned in this context, but were not explicitly excluded either.

[13] Kupang informants described ***kola***, which was not included in this series, as significantly larger than ***kapàha*** and ***tariku*** and "almost as large as ***mbaku***." (Although Onvlee and Kapita describe the ***kola*** as relatively small, their wording suggests that the comparison is with the Brahminy kite or another large hawk.) Also missing from the Rindi comparison is the ***kuu***, which Kupang sources described as the smallest diurnal raptor.

[14] Coates and Bishop (1997:247) describe *Haliastur indus* as a scavenger, and with regard to diet mention only "carrion, insects, fish, etc." MacKinnon (1991:84) says that it feeds on "almost any animal material, dead or alive," and that it "catches small animals, steals larger prey and scavenges along waterways...delicately picking up floating debris." Referring to Bali, Mason and Jarvis (1989:45) note that the bird has a "reputation as a stealer of chickens," but otherwise characterize it as a "general scavenger." As regards *Haliaeetus leucogaster*, the same authors describe the sea-eagle as snatching fish and sea snakes from the water, occasionally feeding on carrion, and sometimes hunting fruit-bats.

[15] Major settlements in eastern Sumba are mostly located in proximity to rivers, and most are within several kilometres of the coast.

[16] Speaking their own language, eastern Sumbanese use ***banjaru***, 'row, line, group,' to express the idea of '(natural) kind.' ***Ngia***, 'place, position,' subserves the same function in some contexts. Thus, ***hangia hangia*** (***ha-***, 'one, each') means 'all kinds (of things)' (see further Onvlee, s.v. ***ngia***).

[17] Also worth noting is Wielenga's (1917:33) comparative listing of ***mango***, a cognate of ***manginu***, as the term for 'bird' in the western Sumbanese language of Lamboya. That ***manginu*** might include more than passerine birds was suggested by a Kupang informant, a young man from Lewa, who identified ***kahuhu*** (sandpipers) as an instance of the category.

[18] In the report of his expedition, Dammerman (1926b) describes a honeyeater (*Myzomela* sp., p.79), a fantail (p. 79), a whistler (p. 24), and the yellow wagtail (p. 36). Although he

observed the honeyeater and fantail in eastern Sumba, in his shorter article (1926a) Dammerman does not list eastern Sumbanese names for these species, only a western Sumbanese name for the fantail and another for a sunbird (*Cinnyris buettikoferi*, apparently *Nectarinia buettikoferi*). The whistler (identified as *'Pachycephala fulviventris'*) is evidently *Pachycephala pectoralis*, the Common golden whistler, the only whistler recorded on Sumba. Dammerman describes the bird as very common.

[19] ***Nggonggali*** probably reflects of Proto-Austronesian ****'enggang*** (the initial /e/ represents the schwa; cf. Bahasa Indonesia ***enggang***), 'hornbill' (Dempwolff 1938:49; cf. Wurm and Wilson 1975:104). Interpretations of ***nggokaria*** (heron) were mentioned earlier.

[20] None of categories in Table 1 apply exclusively to seabirds or species found only on the coast. From experience in Flores, I would guess that cormorants and grebes can be classified with ducks as ***rendi***. The classification of birds like plovers and pratincoles (see Appendix 1) with sandpipers (***kahuhu***, ***pipi***) would also not be surprising.

[21] In 1975-76 I sometimes observed flocks of bee-eaters (*Merops*_spp.) when travelling between Rindi and the port town of Waingapu, but unfortunately never in the company of informants. A Sumbanese man in Kupang gave ***kahi*** as a term for bee-eaters, which he identified from illustrations and descriptions. But this name is probably not distinct from ***kahiku***, a reference to kingfishers, which resemble bee-eaters in appearance, diet, and nesting behaviour. Among the Nage of Flores, who do have a special term for bee-eaters, specimens viewed at a distance, flying high overhead, are sometimes identified with the term for swallows and swifts (Forth 1996:92). Bee-eaters and the dollarbird are both non-breeding migrants on Sumba.

[22] The pairing occurs in the expression ***hibu nggauka, hibu rawa***, 'nest of the friarbird, nest of the pigeon,' a euphemism for the male genitalia (Onvlee, s.v. ***nggauka***). If the specific referent is the male scrotum and testicles (***tilu***, also meaning 'egg'), then evidently the nest of any bird could serve as the metaphoric vehicle. However, the fact that these two kinds in particular are selected can be ascribed to the mythological contrast of ***koka*** and ***rawa***, as the two birds that contested over such matters as whether or not humans should die and give birth, in order to replace themselves (see Forth 1992). Their association with reproductive organs in this ritual speech context is thus intelligible with reference to their association in myth.

[23] Several popular similes feature yet other birds. Onvlee records the following: ***paana kalukingu***, 'to have (raise) children like a ***kaluki;*' *pari kalukingu***, 'as strong as a ***kaluki;*' *parara ngandu yàpingu***, 'to have a mouth as red as (the bill of) a ***yàpi***' (said of youngsters who consume betel and areca); and ***patutu powangu***, 'to cluster, huddle together like quails.' The first expression alludes to the fact that Megapodes incubate their eggs under a large pile of debris, and therefore appear not to look after their offspring to the same extent as other birds.

[24] More often, songs of this sort are performed by the human characters themselves. In one case (C. Forth 1982: 93-92), the dove effectively takes the place of the hero, assuming his identity in the lyric. In another myth, the human hero is born in the form of a dove (***mbàra***; Wielenga 1909).

[25] This idea, recorded in Rindi, is also mentioned by Kruyt (1922:559-60). Kruyt describes the owl as the "personification of the witch" and as the Sumbanese "bird of sickness and death." An owl alighting on the roof of a house forebodes certain death for the owner. In the Kambera region, when its nocturnal cry is heard, children sleeping on their backs should be placed on their side. One should also not comment on or respond to the sound, for this could result in death, construed as an indication that the person had "answered the call."

[26] Kruyt (1922:559) says that owls were not considered significant in times of war. However, he also notes that if warriors heard an owl screeching they should go under a tree and make an offering of betel and areca to prevent "the evil associated with this bird" from following them.

[27] The lumping of numerous small birds in the taxon labelled ***manginu*** might at first appear to be an instance where utilitarian concerns have a preponderant influence on the emergence of an intermediate taxon. This is contradicted, however, by the inclusion in ***manginu*** of ornithological kinds that are known not to infest crops, but which especially in regard to size and form do resemble the crop pests. Also, of course, by no means all avifaunal destroyers of crops are classified as ***manginu***.

[28] A similar argument could be made in regard to the opposition of empirical (or intellectualist) and utilitarian values. A more comprehensive, cognate question is whether symbolism is to be understood as an intellectual activity or product or, as Malinowski argued, a kind of utilitarianism.

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The Cultural Relations of Classification, an Analysis of Nualu Animal Categories from Central Seram. Roy Ellen. Cambridge University Press, Cambridge. 1993. Pp. 315. $80.00 (cloth). ISBN 0-521-4311-4.

In *The Cultural Relations of Classification,* Roy Ellen has compiled an impressive collection of ethnozoological data complete with taxonomic charts, reviews of past theoretical approaches, appendices with local glosses and ecological zones, and his own definition of cognition as it relates to culture and classification. Although written in 1993, the book is still a relevant and important resource today with a resurgence of interest in the fields of ethnobiology and ethnoecology. The data for the book are drawn from a series of field visits to the Nualu of south central Seram, an island in eastern Indonesia. It is interesting to note that although classic ethnobiology has been generally perceived as "scientific," Ellen describes his impression of ethnobiology in the late 1970s as nodal, linking collective representations with cognitive processes. He states these processes are intriguing to him because they link "socio-linguistic positivism with interpretive post-modernism" (1993:2). Given this description it is easily understood how Ellen diverges from classic ethnobiological approaches. He focuses on the combination of scientific approaches with fluid boundaries, overlapping classes and fuzziness, while many ethnobiologists would most likely be appalled at any discussion of the post-modern in relation to ethnobiology.

Throughout this work, Ellen both heeds the accomplishments of his predecessors and contemporaries in ethnobiology while he simultaneously criticizes the methodological approaches and analysis of some of those same colleagues, particularly Berlin, Raven, and Breedlove (Ellen 1993, see also Berlin 1992).

Ellen's primary theoretical concern has been with classification as "situationally adapted and dynamic devices of practical importance to their users, reflecting an interaction...between culture, psychology and discontinuities in the concrete world; a lexical and semantic field firmly embedded in a wider context of beliefs and social practices" (1993:3).

Two areas where Ellen diverges from traditional ethnobiological approaches are: 1) methods of data elicitation and 2) the interpretation of the language of classification. The etic versus the emic view has been the subject of much debate in anthropology. Many believe that researchers tend to view cultures from an etic perspective even if they are skilled ethnographers. Ellen contends that the use of classic ethnobiological systematic methods, without unstructured ethnographic interviewing and observation may lead to faulty conclusions regarding classification and taxonomies. Furthermore, he believes that a predisposed belief in hierarchical structures such as the Linnaean system biases some ethnobiologists to assume that the societies they study do indeed possess a hierarchical system of classification. Ellen's discussion of the language of classification attempts to provide the reader with background on ethnobiological approaches of the past and at the same time critiques these approaches in comparison with his own. One problem with this critique is that his use of terms is often an inaccurate representation of the works he cites. Ellen's main point in offering this background for the reader is both to acknowledge the vast body of ethnobiological research that has pre-

ceded *The Cultural Relations of Classification,* and at the same time provide the groundwork for his approach to ethnozoology and classification of the natural world.

Ellen provides several specific cases that are intended to illustrate the biased methods he finds problematic. Here, I provide a brief description and counter-explanation of a few cases. Ellen gives an example (assuming he is replicating a biased classic ethnobiological approach) of the way in which the question "what is *nakatua wekae* (red-sided eclectus parrot) a kind of?" encodes an answer because the answer is *nakatua*. (1993:25). What Ellen fails to acknowledge is that in a systematic ethnobiological study, the question may not be asked in that way, because a specimen could be pointed to without using the name *nakatua* at all (Brent Berlin, personal communication 1995, Berlin 1992). Another way of asking the question would be, "Does *nakatua* have any relatives?" Moreover, Ellen provides another example of what he considers a culturally inappropriate elicitation method with the question (again, assuming a hierarchically biased classic ethnobiological approach), "'What is *asu* (dog, *Canis familiaris*) a kind of?'" (Ellen 1993:25). He points out that this is culturally inappropriate because a dog is not a kind of anything, except maybe an animal. At this point the reader is lacking information about whether or not there is more than one type of dog on the island of Seram. Later Ellen describes dog, *asu*, as one of Berlin's unaffiliated generics, whereas in Berlin's more recent approach, if there is only one type of dog, then the dog may be considered by ethnobiologists to be a monotypic genera, that is a generic class with only one member (Berlin 1992:33).

Other terms that are confused with current uses in ethnobiology are productive, optional uninomial and binomial. It is entirely possible that Ellen was unaware of, or lacked access to, other ethnobiological research that occurred simultaneous to the time of his writing. Regardless of the reason for this divergence of terminology, it is important that the reader is aware that Ellen often provides misleading secondary explanations of other ethnobiological researchers' usages of classification language. Another possible reason for differences in perspectives and approaches is that Ellen's work is ethnozoological, whereas much of the work of ethnobiology has been concerned with ethnobotany.

Ellen's attempt to link the ideational and operative is indeed different from the ethnobiological studies with which he compares his work. Ellen (1993), Hunn (1985), Rappaport (1979), Nazarea-Sandoval (1995), and Bellon (1995) all attempt to link the cognitive processes with behavior and decision-making. Different objectives seem to have motivated the various research approaches to which Ellen refers.

Early pioneers in the fields of ethnoecology, Frake (1962) and Conklin (1969), were interested in both classification and behavior through a cultural relativist approach. Some later ethnobiologists were inspired by their work, but pursued another direction, in search of universal compartments in the human mind. With the search for a universal understanding of how humans order their natural world, the debate between utilitarian and intellectual basis for classification of plants and animals was spurred in the late 1960s and early 1970s. Ellen's perspective clearly leans toward a utilitarian approach (Hunn 1985), but rather than rely solely on

usefulness, and/or cultural salience in considering the utilitarian categories, Ellen adds the dimensions of habitat, behavior, sound, smell, religion, and cultural context to a traditional cognitive categorization primarily based on perception of morphological qualities (and occasionally sound, as in the case of birds (Berlin 1995)). This tendency toward a more holistic ethnoecology is a valuable advance in the field. I find Ellen's attempt to include habitat and biotopes in his analysis especially useful when considering the field of ethnoecology in relation to decision-making regarding natural resource use.

Ellen seems to follow Rappaport's (1979) earlier attempts to include an analysis of ideational and operational basis for classification, a multilevel decision making process. In doing so he develops the theory of "prehension" which stresses the situational bias of classification. He believes that the kinds of cognitive processes that he has proposed are apparent in the "social construction of categories." It is this combination of approaches in which I find both the strength and weakness of Ellen's viewpoint. While the inclusion of cultural basis and a broader range of contributing factors in classification schema of particular societies liberates us from a rigid ethnobiological approach, it also de-emphasizes a cognitive approach that examines the way the human brain functions. It is clear that Ellen believes in a heavy influence of the sociocultural construction of cognitive processes. Ellen acknowledges some type of hierarchical ordering is necessary in the human storage of knowledge, but he proposes a system of overlapping levels of hierarchy, and clearly states that some forms of classification among the *Nualu* are varied, therefore they fit more than one level at a time.

I find the book to be a useful resource for ethnoecology, especially because Ellen has explored territories with limited previous research, but I propose caution regarding comparisons of his work with other ethnobiological works because of the differences in terminology and Ellen's sometimes misrepresented re-explanation of certain terminology and concepts. I also noted that Ellen's references include few sources of publications from the 10 to 15 years prior to publication of the book; he seems to be responding to and drawing mostly from works of the 1970s and early 1980s.

One should consider the purpose of Ellen's work along with Bellon (1995), Dove (1993), Frechione et. al (1989), Gragson and Blount (1999), Posey et al. (1984), Nazarea-Sandoval (1995), Nazarea (1999) and, Warren, et. al (1995), to name only a few, as examples of an integrative approach to understanding the cultural basis for classification and its implications for resource use. In these contexts, *The Cultural Relations of Classification* provides a functional reference for those interested in ethnoecology and ethnobiology, but readers should refer to other current research in cognition and ethnobiology (see Atran 1999) if they are more concerned with cognitive taxonomic classification.

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KNOWING, GATHERING AND EATING: KNOWLEDGE AND ATTITUDES ABOUT WILD FOOD IN AN ISAN VILLAGE IN NORTHEASTERN THAILAND

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ABSTRACT. — In societies undergoing economic and social transformation, the level of knowledge about local resources, and attitudes toward them, can be affected by a variety of factors including cultural identity, identification with local traditions, cultural transformations, economic status, education level, age and gender. To address the topic of what factors affect traditional wild plant use and knowledge in Northeastern Thailand we interviewed and tested male and female villagers in different age categories. Each interviewee was asked to identify and provide information about photographs of 40 wild food items. Additional information was obtained through ethnographic research in the village. The results indicate that there are gender differences in the use and procurement of wild food items. However, most villagers, despite their economic level, still prefer wild food over cultivated food. Using a knowledge and attitude test, it was also found that women are better able to identify items correctly, but that there are no gender differences in knowledge of other factors pertaining to the wild food items. Additionally, adults consistently scored higher than children. Consequently age, and thus indirectly, exposure to traditional subsistence practices, also is related to knowledge about wild food resources. Our results suggest knowledge about wild food is being lost within the community despite retention of the taste for these items and desire to retain them in the diet.

Key words: Thailand, wild food, food preference, gender, age.

RESUMEN.—En sociedades sometidas a transformaciones económicas y sociales, el nivel de conocimiento sobre recursos locales y actitudes sobre ella pueden ser afectadas por una variedad de factores, entre ellas la identidad cultural, identificación con tradiciones locales, transformaciones culturales, el estado económico, nivel de educación, edad y sexo. Entrevisitamos y examinamos a varios aldeanos femeninos y masculinos de edades diferentes para exponer cuales factores afectan el uso tradicional y el conocimiento de plantas salvajes en la region Noreste de Tailandia. Se el pidió a cada aldeano que identificara cuarenta fotos de artículos de comida salvaje. Obtuvimos información adicional através de investigaciones etnográficas hechas en el mismo pueblo. Los resultados indicaron que existen diferencias en el uso y obtención de artículos de comida salvaje. Sin embargo, la

mayoría de los aldeanos, a pesar de su nivel económico, prefieren comida salvaje a comida cultivada. La única diferencia que se reveló usando pruebas de conocimiento y aptitud fue que las mujeres lograron mejores resultados identificando los artículos de comida salvaje correctamente. Adicionalmente, los adultos dieron resultados más altos que los niños. La edad, e indirectamente la exposición a prácticas tradicionales de subsistencia, también están relacionadas al conocimiento de comida salvaje se pierde ante la comunidad, a pesar de la retención del saber de éstos artículos y el deseo de mantenerlos en la dieta.

RÉSUMÉ.—Dans les sociétés qui entreprennet des transformations, le niveau de connaissance sur les ressources locales et les attitudes envers ces ressources, sont affectés par une variété d'agents inculant l'identité culturelle, l'identification avec des traditions locales, des transformations culturelles, le statut économique, le niveau d'éducation, l'âge et le sexe. Pour aborder le sujet des agents qui affectent l'usage traditionelle des plantes sauvages et la connaissance des plantes au nord-est de la Thaïlande, on a fait des entrevues et on a examiné les homes et les femmes des villages d'âges différents. On a demandé à chaque sujet d'identifier et de donner des renseignements de quarante aliments sauvages qui ont été photographié. Les informations supplémentaires ont été obtenu à travers la recherche ethnographique dans le village. Les resultants montrent qu'il y a des differénces entre les sexes dans l'acquisition et l'usage des aliments sauvages. Cependant, la plupart des habitants du village, malgré leur statut économique, préfèrent les aliments sauvages aux aliments cultivés. Employant un examen de connaissance et d'attitude, on a également noté que les femmes sont meilleures à l'identification précise des articles mais il n'existe pas une differénce de connaissance entre les seces concernant les autre facteurs à propos des articles sauvages. De plus, les marques des adultes étaient invariablment plus hautes que celles des enfants. Par consequent, l'âge, indirectement, ainsi que l'exposition aux practiques traditionelles de subsistance, fait également partie de la connaissance sur les ressources de la nourriture sauvage. Les resultants suggèrent que la connaissance des aliments sauvages est en train d'être perdue en dedans de la communauté en dépit du fait qu'ils retiennent le goût pour ces articles et leur désir de les retenir dans leur régime.

INTRODUCTION

Human-plant interactions are one aspect of a society's construction of nature and the landscape. Recently, researchers have begun to explore the factors that influence the knowledge people have about their environment. In particular, researchers have begun to ask questions that highlight why people know about some plants and not others (Nolan 1998) and what determines these perceptions. Cultural factors often take precedence over other considerations such as species availability or abundance. The process of choosing and obtaining specific plants or animals speaks to how people view themselves, each other and the environment. Thus, social relationships and perceptions about the environment are enacted in the procurement of wild food resources.

In this paper we explore the relationships among people, the natural environment and the ways individuals preserve and transform their culture and environment. We specifically focus on knowledge of wild or semi-domesticated

plants and animals and practices concerning the use of these resources because they create an intensive interaction with the physical and social environment.

Since consumption usually occurs in the home it has often been assumed that women control the production of consumption as well as the food habits of the family (McIntosh and Zey 1989; Levin 1943). However, non-domesticated/gathered and semi-domesticated food enters the household through a variety of channels. Traditional foods, which still form an important part of the diet, may be procured by the female head of household, husband, male and female relatives, friends, neighbors and children. Within a community, knowledge, patterns of resource use, and the landscape, are affected by gender, class, economic level and personal life experiences. Consequently, theories about the patterns of decisions and actions that occur must take these differences into account. Complex local histories of resource use will do much to increase our understanding of the ways that local systems of resource management transform themselves in response to global processes; in particular they can help us evaluate the ways in which the sustainability of rural production practices are ensured or undermined (Collins 1991). One of the goals of this paper is to describe the variation in knowledge and resource use within a community. We specifically focus on gender; however, since knowledge of the environment is embedded in culture, social and economic factors also are addressed.

DESCRIPTION OF THE STUDY SITE

Physical landscape. —Northeastern Thailand, also called Isan, provides an excellent setting to observe variation in knowledge of the environment and resource use in the context of gender roles and social relationships. Geographically, Isan is set off from other regions by mountains and is characterized by erratic rainfall and poor soils. This gently sloping plateau of undulating hills, terraces and flood plains also includes a zone of hills and upland areas in the west and the south (Hafner 1990) that extract moisture from the southwest monsoon airstreams. Thus, while contributing to the biodiversity of the region, these hills also make the area more susceptible to droughts. Today, the low and erratic rainfall, nutrient poor soils with poor moisture-retention capability, and sparse surface water combine to make the region difficult for wet-rice farming. However, some of the earliest archaeological sites in Asia with evidence of agriculture, pottery and bronze work are located in the Northeast (Higham 1982; Solheim 1968). The semi-arid environment greatly influenced the traditional subsistence system and other adaptations to the habitat.

Cultural landscape. —Nature's impact on culture and personal identity has been great in Isan. Regional identity, which involves a sense of belonging and pride, as well as in-group and out-group categorization, is strong and tied to the landscape and wild resources, especially those that are involved in the cuisine of the region. Traditionally, the people in the Northeast adjusted to variability in these habitat factors through the development of a combined subsistence system, in which they complemented their reliance on the staple glutinous rice and other subsistence

FIGURE 1.–The landscape surrounding the village. Paddy fields (background) and sugar cane cultivation area (foreground).

crops with large inputs from wild food (Moreno-Black 1994; Phongphit and Hewison 1990; Pradipasen et al. 1986; Somnasang et al. 1988; Tontisirin et al. 1986). Isan people have a great deal of traditional knowledge concerning the environment, wild plant and animal resources. They are also knowledgeable about predicting climatic patterns, cropping practices, green manuring, and energy extraction (Rambo 1991).

The rich flora and fauna in the Northeast provide a vast array of edible and useful plants and animals that are gathered for a wide variety of purposes, including food, building material, crafts, medicinal use, and religious purposes. These indigenous practices, and the knowledge that they represent, have been acquired over many generations and are deeply ingrained in regional Thai culture (Phithakpol 1990). The diet, characterized by a staple core of glutinous rice, fish, and fish products, is supplemented by a wide variety of local wild and semi-domesticated plants and animals (Moreno-Black et al. 1996; Moreno-Black 1994; Ngamsomsuke et al. 1987; Ngarmsak 1987; Pradipasen et al. 1986; Somnasang 1996; Somnasang et al.1998, 1988). These important items —collected from forests, upland fields, rice paddies, gardens, house areas, canals, ponds, swamps, rivers, and dam areas —contribute valuable nutrients. Coupled with a variety of cooking methods, they add diversity to a potentially monotonous diet. Northeastern food has been one regional specialty that has begun to gain popular interest and demand in Bangkok (Van Esterik 1992). In fact, Isan food was characterized and romanticized in popular folk media and has acquired both national and international recognition with the initial publication, gain in popularity, and wide distribution of the novel *Child of the Northeast* (Boonthawee 1976).

FIGURE 2.–A scene from the village showing houses and dirt road.

Life-ways are changing rapidly in Isan and villagers are being affected in terms of economics, social relationships and culture. At the local level, a growing influence of the nationalized central Thai image, an increase in development projects, and a rising monetization of the economy are beginning to influence the regional lifestyle in a variety of ways. Local resources, which used to dominate home use,

FIGURE 3.–A gathering party.

FIGURE 4.–A village woman on her way to gather red ants.

are being used as cash generators. At the same time the abundance of these resources is declining due to national economic and forestry programs that do not emphasize the local species. The local economy has expanded to emphasize cash cropping, wage earning and both temporary and permanent out-migration of adults.

RESEARCH METHOD AND DESIGN

Selection of research village. — The research village was selected from twelve potential villages in the province of Khon Kaen. All of the potential sample villages were chosen using secondary data obtained from the Khon Kaen Policy and Planning Division, The Khon Kaen Governor's office and district-level extension offices. Additional information about the villages was obtained through interviews with government officials at provincial, district, and sub-district government.

Rapid rural appraisals (RRA) (Chambers 1980; Lovelace, Sukesine and Sugin 1988) were conducted in the twelve villages in the province of Khon Kaen. The headman in each village was interviewed in order to obtain information concerning the general profile of the village, the local environment, occupations of the residents, problems of concern within each village and the use of local wild food resources. Additionally, two or three households in each village were selected on the basis of economic level (poor, middle, rich). Semi-structured interviews (Grandstaff and Grandstaff 1987) were conducted with the individuals from each of these households to acquire information about wild food utilization.

Analysis of the headman interview and villager interview data enabled us to select one village site for an in-depth study. The chosen village was selected be-

cause it represented an average sized village, was characterized by high wild food use, and villagers obtained wild food from three main sources (forest, local water resources and paddy fields). Additionally, the villagers were not heavily involved in selling wild food at the market in the Khon Kaen. Finally, the village was moderately accessible all year round, but was not located on a paved highway.

In-depth village study. — This part of the research involved intensive participant observation and in-depth interviewing in the study village (Figure 1). Our mapping of the village showed that 105 of the 112 houses that were present were occupied. Census information was obtained from all of the 105 households. The census interview included demographic information as well as questions concerning household economics, agricultural practices, wild food use and transplanting activities. The environment surrounding the village was also surveyed in order to record the sites of forest, cropland, and water resources. The study sample households were selected by stratified random sampling based on economic stratification developed in conjunction with the headman. The 64 households in the sample (3 high income, 38 middle income and 23 low income) represent 60% of the total

FIGURE 5.–Separating red ant eggs from red ants.

households in the village. Individuals from these households were interviewed about wild food gathering practices, the types of wild food that are gathered, and how the food items are used. Participant observation, focusing on food procurement, processing and preparation activities, was used to amplify the interview data. The interviews were used to obtain information about gathering practices; knowledge of wild food habitats; the ways wild foods are used; and specific wild food management practices such as transplanting and propagation techniques.

A "Knowledge" test and an "Attitude" test were administered to adults from the study sample and children who attended the one school in a nearby village village. Sixty-four adults (32 women and 32 men) and forty-one children (21 girls and 20 boys) were interviewed using a set of laminated photographs of 40 wild food items selected from information obtained during interviews and participant observation (Table 1, Appendix A). The forty food items were divided into four categories: plant (32 items), fish (5 items), insect (2 items) and snail (1 item).

TABLE 1.—Age and gender distribution of "Knowledge and Attitude Test" participants.

Age	**Female**	**Male**
10-11	21	20
15-25	8	8
26-35	8	8
36-45	8	8
46-55+	8	8
Total	***53***	***52***

Mean age of school children = 11 years

Mean age of the adult sample: Males = 37 years; Females = 36 years

Each adult was asked to identify the item (identification test). These data were used in the odds ratio analysis and the scoring system described below was then utilized to compute the I score component of the knowledge test. The knowledge test was composed of several parts and individuals were scored on: ability to identify an item (I score); culinary information, such as how to eat, prepare, and cook the food as well as its taste (C score); non-culinary uses (O score); horticultural practices, such as transplanting, maintaining or propagating the item (TP score); and knowledge of procurement practices (P score). Each person could score up to ten points per item (Table 2) and a total of 400 points for the complete test of 40 items.

For the attitude test individuals were also asked about their attitude toward each item especially in terms of taste qualities and consumption preferences. The children were given the same set of laminated pictures of the wild foods; however, the questions were simpler and shorter since they were only asked to identify each item and express their knowledge of and attitude toward the item.

TABLE 2.—Criteria and scoring system for the Wild Food Knowledge Test.*

CRITERIA	NUMBER OF POINTS		
	No Knowledge	Incomplete Knowledge	Knowledge
Item Identification (I score)	0	1	2
Culinary Knowledge (C score)	0	1	2
Procurement Knowledge (P Score)	0	1	2
Other Use Knowledge (O score)	0	1	2
Horticultural Knowledge (TP Score)	0	1	2

* No Knowledge = Interviewee lacks any knowledge or answers incorrectly.

Incomplete knowledge = Interviewee either has incomplete knowledge of the item.

Knowledge = Interviewee demonstrates full knowledge in terms of all criteria.

RESULTS AND DISCUSSION

In the Northeast, resources are recognized and perceived as useful within the context of the environmental and social reality of the region. Knowledge of local plants and animals, especially those species that are commonly consumed as food, accumulates over generations and reflects the way people learn from and about their environment. The villagers relied heavily on a variety of non-domesticated plants and animals. A diversity of habitats was utilized, including paddy fields, upland areas, forests, ponds, streams, swamps, rivers, and other water reservoirs. Commonly utilized items include leafy algae, green plants, fruits, mushrooms, amphibians, crustaceans, fish, birds, reptiles, insects and mammals. Wild foods were also used as condiments and often contribute to the distinctive flavor of Isan food. Wild food entered the household in a variety of ways: 1) production through family agricultural activities; 2) procurement through gathering, fishing and hunting by household members; 2) gifts from relatives and neighbors, 3) exchange with other individuals in the village or nearby villages; and 4) purchase. Consequently many individuals can contribute to a household's food consumption and men, women and children all have some involvement with wild food beyond consuming it.

Shared traditions, beliefs and attitudes concerning wild food use. —The majority of people in the village reported eating or using wild food at the present time or in the recent past. The majority of villagers indicated they liked to eat wild food, often preferring wild food to cultivated food and food from the market. Only 3 people (5%) reported they did not like wild food, while only 3 people felt that they like wild food as much as cultivated food. The villagers believe that wild food is necessary and that it is the most important food for everyday life. Analysis of the in-depth interviews revealed that males and females did not differ in their attitude concerning wild food and both men and women preferred to consume wild food over cultivated food.

TABLE 3.—Reasons for preferring wild food over cultivated food (n = 64)

REASONS FOR PREFERRING WILD FOOD	RESPONSES		
	Female	**Male**	**Total**
Taste Factor			
Taste: delicious, taste better, etc.	19	15	34
Higher nutritional value, less fat	6	7	13
Fresh, better than market food	6	6	12
Natural	5	5	10
Total	***36***	***33***	***69***
Ease of Procurement and Safety			
Less poisonous agents, fewer chemical, less harmful	17	17	34
Easy to obtain, can gather on their own	9	7	16
Cleaner than market food	6	3	9
Total	***32***	***27***	***59***
Economics			
No need to buy food, save money	15	14	29
Total	***15***	***14***	***29***

Note: Maximum answers = 3 per person

The villagers gave a variety of reasons why they preferred wild food over cultivated food (Table 3). The most frequent reasons were related to qualities concerning: 1) taste; 2) ease and safety; and 3) economics. The concept of taste is obviously very important and included a number of important components. First, villagers often mentioned the fact that wild food is more delicious and tastes better than cultivated food. They also thought wild food was fresher and tasted more naturally sweet than market food. This is partially because of the inherent qualities of the food as well as the fact that villagers can gather wild food and consume it soon afterwards. Villagers also indicated that wild food was better because it grows naturally, has more nutrient value, especially vitamins and protein, and less fat. These specific nutrition-related characteristics, which some individuals are now ascribing to wild food, are most likely derived from information obtained from government sponsored health and nutrition education programs.

The second group of reasons for preferring wild food revolved around the concept of ease and safety. Villagers preferred wild food because it was easy to obtain or they did not have to spend time or energy cultivating it; it is natural and grows by itself. Villagers consider wild food safe in part because they assume only cultivated food would be contaminated with fertilizers or insecticides. However, it is likely that many of these items, especially those growing in paddy fields and gardens, are contaminated with fertilizers and pesticides. Wild food is also considered to be clean because it comes from the natural environment. It is not mixed with food that can become dirty at the market in town.

The last set of reasons is related to economics. The villagers considered wild food to be good because they did not have to pay money for it, thus they were able to save money by eating wild food. Many villagers felt that poor people needed to

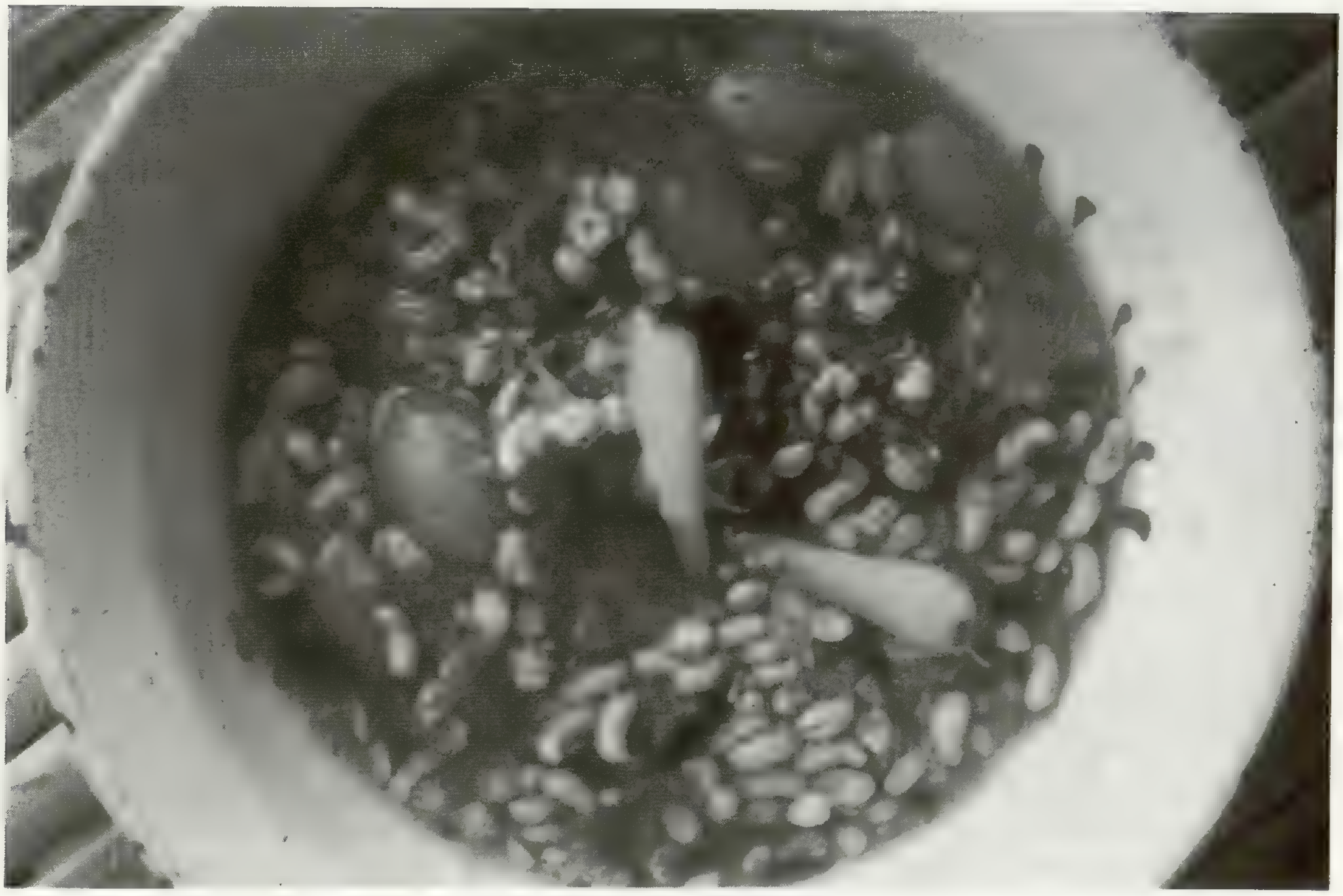

FIGURE 6.–A typical dish made with red ant eggs.

rely on wild food because they do not have much money to spend on food. However, the villagers did not look down on individuals who relied on wild food. Many people also recognized that even rich people utilize wild food as a way to save on spending money for something that is available without monetary cost. Consequently, wild food was not stigmatized as a "food of poverty."

Procurement patterns were affected by time factors. Gathering is as commonly done in conjunction with other activities, such as gardening, agricultural wage labor or tending cattle, as it is done as its own activity. Gathering patterns are to a large extent dependent on both the seasonal availability of the food and seasonal workload of the villagers. In the rainy season two factors impact the amount of time spent gathering. First, because wild food is abundant, less gathering time is required. Secondly, in this season villagers are actively engaged in rice agricultural tasks so they tend to choose to gather food that is close at hand. Similarly for those households that are moving into cash oriented agriculture, such as growing asparagus or cucumbers for the commercial market, the opportunity to gather wild food is limited. Thus, it was not surprising that in the rainy season 53% of the women spent an hour or less gathering. On the other hand, in the cool season, when there are fewer agriculture-related demands, 64% of the women spent one to two hours gathering. In the hot season, however, the scarcity of wild food, more than time constraints from other activities, results in the village women spending more time gathering wild food, and 56% spent two or more hours in gathering activities.

The selection of food is influenced not only by time constraints and preference but also by attitudes about the identity of individuals who are known to consume

the food. Personal identity and food consumption are linked in powerful ways. The villagers in this study expressed a variety of opinions concerning individuals who consume wild food. These associations consciously and unconsciously affect the selection of these foods within the village context. Villagers indicated that they believed that wild food is essential for the poor. They indicated that the poorer people in the village have to depend on wild food, have more experience obtaining it, and are very knowledgeable about how and where to procure wild food. The villagers also expressed the sentiment that the poor also exchange wild food for other food items such as rice. However, villagers with all these opinions also indicated that they did not look down on individuals who gathered wild food; instead, they were considered industrious and hardworking and often a degree of admiration was voiced.

Conflicting beliefs were expressed when others in the village indicated they believed rich people consumed more wild food because they had money to buy it when it was not easy to obtain or when they were too busy to gather it themselves. A few individuals indicated they believed rich people ate more wild food because, unlike the poor people who had to engage in wage labor, wealthy individuals had time to obtain non-domesticated food. In these individuals' minds, the poor people in the village relied on cheap, prepared foods from the village shops. For this group, purchased food was associated with poverty and was considered to be poor quality foods.

When asked how urban people view wild food, the villagers were of the opinion that town people like non-domesticated food and are often eager to purchase these items for ingredients in specific dishes, or as snacks. Villagers believed that wild food has a high market value, sells better than domesticated food and thus brings them a better earnings than domesticated food. A very small number of the interviewees (10 individuals) differed from the general opinion of the rest of the sample by thinking that towns-people had a poor attitude toward wild food, look down on village people who eat wild food or think that wild food, especially insects and some animals are not clean and are disgusting. These villagers also thought that the urban people may look down on villagers who eat this type of food.

Variation in wild food knowledge. —Variation in knowledge of wild food was evident in the study sample, although the majority of villagers stated a preference for wild food and continued to seek out and procure wild food items. The knowledge test was used to measure recognition, culinary knowledge, consumption, procurement, other uses, and transplanting and horticultural techniques (Table 2).

An odds ratio (Agresti 1990) which interprets differences between two population proportions or possibilities, was employed to estimate how frequently one population identified a wild food correctly compared to the other (Identification test). We first compared men and women and then compared adults and children in terms of their ability to identify items in the wild food test (Table 4). In this analysis we grouped items into categories (plants, fish, and insects). The odds ratio analysis showed that, compared to men, women were more likely to be able to identify plants (1.38 times), insects (1.38 times) and fish (1.07 times).

TABLE 4.—Gender based comparison of likelihood of correct identification of wild food.

Gender	Female		Male		Odd's Ratio
	I	N	I	N	
Adult					
Plant Group	626	1006	552	1014	1.38*
Fish Group	59	129	64	145	1.07
Insect Group	45	63	40	62	1.38*
Total Wild Foods	***730***	***1230***	***656***	***1253***	***1.34****
Children					
Plant Group	175	326	155	312	1.17*
Fish Group	34	76	42	73	0.60
Insect Group	16	29	13	32	1.80*
Total Wild Foods	***225***	***445***	***210***	***429***	***1.07***

Note: I = Total correct identifications

N = Number of valid samples

* = significant difference at p _.05

Among children, girls were more likely to identify wild plant species correctly (1.17 times), and insects correctly (1.80 times), than boys. However, girls recognized fish less often (0.60 times). When the children and the adults were compared concerning their ability to identify the wild items, the odds ratio showed that adults were 1.31 times more likely to identify plants and 2.35 times more likely to correctly identify insects. But the adults were less likely to identify fish correctly (odds ratio = 0.78) (Table 5). A total of 25 plants were used in the "attitude and knowledge" test. Eleven plants were correctly named by 80% of the children, but there were 16 plants that 20% or fewer of the children could name. However, a very large majority of the students (78%) said they consumed between 13 and 15 of these plants, and they also indicated they liked wild foods.

In general, adult women and girls out-performed their male counterparts in identification of wild food items. Girls were 1.07 times more likely to identify the total three groups of wild food than boys, and adult women were 1.34 times more likely to identify all three groups correctly than the men (Table 4).

TABLE 5.—Age based comparison of likelihood of correct identification of wild food ("identification" test).

Wild Food Type	Adult (N=64)		Children (N=41)		Odd's ratio
	I	N	I	N	
Plant group	1178	2020	330	638	1.31*
Fish group	123	274	76	149	0.78
Insect group	85	125	29	61	2.35*
Total Wild Foods	**1386**	**2419**	**435**	**848**	

Note: I = Total correct identifications

N = Number of valid samples

* = significant difference at p _.05

The wild food knowledge test was also used to compare knowledge of wild food by comparing mean scores on the components of the knowledge test: identification (I score), culinary knowledge (C score), procurement methods (P score), other uses (O score), transplanting and horticultural information (TP score) and total score (S score) (Table 2). The mean scores of each food group were calculated and compared between males and females and among the age groups using an analysis of covariance. The analysis of covariance showed that there was no significant difference between gender in the I, C, P, O TP and S sores. Although women tended to have higher scores in each component, the differences were not statistically significant. However, there were significant differences between the age groups for both males and females for all five categories of the knowledge score: I ($p = .001$), C ($p = .009$), P ($p = .004$), O ($p= .001$) TP ($p = .001$), and S ($p = .001$). Thus, it is clear that the older individuals have more knowledge about plants than the young. However, the age factor was not significant in terms of knowledge of insects or fish.

Retention and loss of knowledge about local nondomesticated resources is an issue of importance to researchers who are concerned with maintaining biodiversity, cultural diversity, and ethnobiological knowledge, and those interested in understanding how culture is expressed and rendered meaningful. An examination of our data shows that gender and age are factors related to differences within this community in terms of knowledge of wild food. This finding is similar to research done by Wester and Yongvanit (1995). When they compared individuals from different villages and levels of education in Isan, they also found that in almost all age groups women scored slightly higher than men on a test of wild plant knowledge. In their sample of 795 males and females (10 - 99 years of age), they also found that there was a general tendency for scores to increase with subject age until about 70 years, when scores of men showed a sharp decline. They further found, in marked contrast to scores of village populations, students, all of whom were younger than 30 years old, scored low. However, Ogle (1984) in her research in Swaziland, found that children recognized a large number of different wild species and reported high consumption of the items. Consequently, she concluded knowledge was not being lost to the extent feared.

Differences in knowledge, both within and between communities and groups of individuals is to be expected, since men and women utilize and define the environment differently. The division of labor that occurs in agricultural communities leads to differentiation in work patterns, contact with resource areas and procurement of resources themselves. That children can have less familiarity or knowledge than elders is also not surprising since they have had less time to accumulate information, fewer life experiences, and are often not as involved as adults are in resource utilization. Additionally, as adults are pulled into wage earning activities outside the village, opportunities for communication of information also decrease or vanish completely.

Differences in knowledge should not be accepted or dismissed lightly since the loss of traditional knowledge among many subsistence-oriented communities in many parts of the developing world has been noted. For example, Anderson (1993) has expressed concern about the perpetuation of such information among

the hill tribes of northern Thailand and Works (1990) recorded that elders in a Peruvian community frequently lament that younger individuals are no longer interested in plants or gardens. Similarly, Maikhuri and Gangwar (1993) observed that knowledge of plants in younger individuals in the Khasi and Garo tribes of Northeastern India was judged to be poor. Similarly, the older villagers in our study often expressed concern about their perceptions of the loss of knowledge among the younger generation. Elders complained about their children and grandchildren not being interested in learning about the procurement and preparation of wild food.

CONCLUSIONS

Loss of traditional knowledge among agricultural communities as they experience the effects of globalization has been noted in many parts of the world. Nonetheless, many individuals remain connected to local practices, at least to some degree. In Isan, the strong connection between ethnic identity and cuisine encourages the preservation of local resources that imbue their taste, texture and odor to Isan cuisine. Many of these items are wild plants and animals. Additionally, many of the plant food items are also integrated into the local belief system regarding health and serve as medicinal plants. The continued reliance on important wild resources has led to items being utilized by different people at different times. Consequently the distinct interests that different segments of society have in the rural productive environment influence resource use and preservation (Collins 1991). However, as suggested by Wester and Yongvanit (1995), the decrease or loss of traditional practices and knowledge appears to be not always a conscious choice. It is sometimes an incidental result of new patterns of living.

Adults are increasingly participating in the new economic patterns, which, rather than being embedded in the mixed subsistence practices, more and more involve cash cropping of introduced and domesticated crops as well as working for wages and both temporary and permanent out-migration. Children and young adults are also affected. Young adults are increasingly attracted to the trappings of the urban, cosmopolitan culture. Children who attend school, especially the higher grades outside the village, are occupied with studies that keep them from participating in subsistence actives to the extent that children did in the past. It also exposes them to different ideas and activities. In the study reported here, the connection between land and life that was deeply embedded in daily survival in the past appears to be in the process of being altered as a result of the adoption of urban values and goals. Individuals are also absent from the locale during the periods of their life when they would have been participating in activities that necessitated the accumulation of local knowledge about the environment and wild food resources. Although they still enjoy and prefer the tastes that these wild food items give to local dishes, and indeed connect them to local ethic identity, they are not as knowledgeable about them as the elders are.

The information obtained in this study highlights the fact that there are vital connections between gender and age (and thus work patterns, division of labor, and participation in the wider national and global processes) and knowledge of

local resources. Women were 1.34 times more likely than men to identify plants, insects, and fish correctly. The knowledge scores showed that women have greater knowledge than men in terms of recognition, gathering knowledge, preparation and consumption knowledge, and uses of wild food. However, the scores from the total knowledge test indicate that there were no significant gender differences. There were significant differences in plant knowledge among the different ages, with the older individuals scoring higher than young adults and children. These differences, which may be indicators of erosion in the local knowledge base, are potentially being exacerbated by both temporary and permanent out-migration, which results in fewer opportunities to learn about their native environment and the resources that are utilized.

It is clear that factors such as gender roles, division of labor and the economic and social impact of nationalization and globalization determine the breadth and depth of knowledge about the habitat and local indigenous resources. These factors are probably more important than resource abundance and diversity in the contemporary conditions of rapid economic and cultural change. The fact that wild food knowledge is largely a construct of such factors has important implications for the survival of both knowledge about these resources, and ultimately the resources themselves. Villagers in the study are aware and concerned about the potential loss of knowledge. They frequently expressed a desire to preserve wild food for the younger generations. They mentioned that some types of wild food were rare, and they feared their children or grandchildren would not get to enjoy them. Villagers often proposed ideas to enhance retention, such as transplanting species, decreasing the amount of wild food gathered for sale, working with officials to develop programs, willingness to comply with laws that would protect native species and habitats, and seeking to develop educational programs directly targeted at children.

Our findings indicate that younger individuals have less knowledge than the elders in the village. It is important, especially from the perspective of the villagers, that local knowledge about wild plants and animals be maintained and documented. We believe government policymakers and development workers should consider ways to integrate local knowledge into the formal education system and incorporate it into relevant projects whenever possible. Efforts should be made to work with village elders to develop resource material such as illustrated pamphlets or monographs about local wild food resources for schools and public libraries.

We also believe that villagers, forestry experts, and government officials could work together to determine ways to preserve indigenous species while still enabling villagers to utilize these resources. Additionally, villagers should be encouraged to develop management strategies that will limit harvesting practices that are currently straining local resources. At the same time, it is vital that the concept of sharing be maintained, so that villagers can procure and consume wild food together, thus enjoying both the social and nutritional benefits that characterize Isan cuisine and culture.

Our study indicates that it is very important to begin obtaining dynamic accounts that relate women's and men's activities to the process of ecological change

and the continuity of local traditions and knowledge. The preservation of knowledge about wild food plants appears to be the result of the continued connection with the local geography, and personal identification with the village or region. This is linked to specific food items or taste qualities, economic pressure, and intrinsic family interest and motivation to preserve traditional patterns. In particular it is important that we recognize the ways in which different interests in the environment are structured by gender, age, class, caste, or ethnicity in order to identify individuals who are knowledgeable about local habitats and resources. Identification of important cultural influences in the construction of local knowledge will be invaluable for the design and application of conservation programs.

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APPENDIX A.—Wild food items used in the Knowledge and Attitude Test*

Botanical name	Local name
Plants	
Amaranthus gangeticus	***phak kaenkhom***
Amorphophallus spp.	***erok***
Antidesma acidum	***mark mao***
Butomopsis latifolia	***pinoy***
Calamus spp.	***whai*** *(rattan)*
Capparis tennera	***mark muay*** *(fruit)*
Cassia siamea	***keeleak***
Centella asiatica	***phak nork***
Cratoxylon formosum	***phak teaw***
Curcuma parviflora	***dork grajeaw*** *(flower)*
Cyclea peltata	***kruamanoi***
Dioscorea alanta	***mon liam*** *(tuber)*
Dioscorea hispida	***kloy*** *(tuber)*
Emilia sonchifolia	***phak linpi***
Garcinia cowa	***somong***
Hydrocharis morsus-ranae	***yopae***
Irvingia malayana	***bak bok*** *(fruit)*
Limnoccharis flava	***phak kanjong***
Limnophilia aromatica	***phak kayang***
Marsilea crenata	***phak waen***
Monochoria vaginalis	***ehin***
Ottelia alismoides	***obab***
Oroxylum indicum	***linfa*** *(pod)*
Polygonum odoratum	***phak paew***
Sauropus androgynous	***kantong***
Solanum trilobatum	***mark kheng***
Stephania brevipes	***huabua***
Thyrsostachys siamensis	***normai huak*** *(bamboo shoot)*
Wolffia globosa	***kipum***
—	***mark pipuan***
—	***liumpua***
Fungi	
Careya sphaerica	***hed phungtam***
Fresh water fish	
Cirrhinus jullieni	***pla khona***
Cirrhina microlepis	***pla suit***
Cultrops siamensis	***pla pap***
Solidago polyglossa	***pla khao huangleang***
Tilapia	***pla kha***
Snail	
—	***hoi sai***
Insects	
Brachytropes portentosus	***ji law***
—	***maeng huakuai***

*Plant identification was determined by consultation with Dr. Sompong Thamathawan and Dr. Samang Homchoen at Khon Kaen University.

Feeding the World. Vaclav Smil. MIT Press, Cambridge. 2000. Pp. xxviii, 360, many text figures, bibliography, index. $32.95 (cloth). ISBN 0-262-19432-5.

This book is an absolute must for all interested in the world food situation and its future. It is the best up-to-date source I have seen on the subject. Smil defines his subject in the widest possible way, and brings together an amazing range of information on all of it. One stands in awe of his data retrieval system. (This is his 15th book, and the others are comparably data-rich.)

The best feature of the book, and intended so to be, is his focus on efficiency as the best way to deal with food shortages in the near future. Much of the book is a long litany of wastes: water and fertilizer wasted in the field, grain lost to weevils and rats in storage, grain fed to livestock that could eat grass, foodstuffs unnecessarily thrown away in processing, and on to plate waste. This last grows ever worse as people live on takeout junk-food and no longer save leftovers. As he points out, we already have the world food problem solved, as far as production goes. We are producing enough food for all humans alive today, and could even provide for the entire population expected to be with us in 2050. The problem is all that loss. And his figures on that are conservative. He believes loss in storage to be around 10 percent to 15 percent; there are much higher estimates.

Smil is a cautious optimist. He tries to steer a course between "cornucopians" and "catastrophists." He dismisses the former (such as the late Julian Simon) with a single tart line: "If the global grain output were to continue growing only as fast as it has done during the 1980s (almost 2 percent a year), the annual harvest of cereals would surpass the Earth's mass in less than 1,500 years…(p. xii)." The catastrophists are much more formidable foes. Much of the book is taken up by debates with Paul Ehrlich and Lester Brown, whose concerns cannot be written off. To be sure, their dire predictions have been wrong; he gives a series of Brown's now-invalidated ones (p. 12). But one might argue that the reason these predictions were wrong is that they scared people into action. After all, they were usually couched in terms of "if nothing is done…."

In any case, something was done and people are now better fed than ever before in history. About 1.2 billion people are hungry, but 1.2 billion are overnourished, so it balances out; the problem is clearly one of efficient allocation, not absolute shortage. (A more politically liberal observer than Smil might say that there is a bit of a redistribution problem there, too.) "If the rich world's food losses could be held to 20 percent of the overall supply, the annual savings…would be equivalent to…nearly half of all cereals on the world market (p. 210)." Mom was right to tell us to "think of all the starving people in Asia"— though, even at the age of eight, I wondered how *my* eating too much and getting fat was helping *them*. Smil has it right: we should stay thin and let the price of food fall.

The bulk of the book consists of a truly incredible assemblage of information on the state we are in — regarding fertilizers, crops, land base, soil erosion, storage, and on to processing, consumption, human nutritional needs, and plate waste. He notes, for example, that some of the gloomy predictions of the 1960s were based on assessments of human protein needs that we now know were far too high. We can get by on a little plant protein; we don't need all that meat. But, if we want

meat, some meats (chickens, pigs) are far more efficiently produced than others (America's adored beef is the worst). Eggs and milk are better still. The greatest value of this book to ethnobiologists, after its basic message of efficiency, is its use as a reference work; it is encyclopedic in coverage of a vast and often obscure literature on agriculture and food.

No one human can bring so much together without making some dubious claims, however. Predictably, most of Smil's are in the optimistic direction, but he has also missed some cheering thoughts.

To begin with the over-optimism, Smil accepts the current projections (by the United Nations and other agencies) that world population will level off around 10 billion in the next couple of generations. I do not believe this. The easy battles have been won: Europe is down to ZPG, East Asia is near it, and some other well-organized, highly educated countries have made a start. The rest of the war is going to be a great deal harder. Birth rates are falling slowly in South Asia and Latin America, but so are death rates. Birth rates are not falling, or not by much, in Africa and the Middle East. In these areas, little or nothing is being done to reduce population increase. China's one-child rules are cracking and the system may crumble. Even the United States continues to grow rapidly, and current governmental policies are increasingly antithetical to demographic leveling off. Absent the most horrific of Malthusian checks, we will probably see rapid population growth throughout Latin America, Africa, and west and south Asia for the rest of this century at least, and appreciable growth in the United States.

This is debatable. Much less debatable — indeed, a clear mistake — occurs on page 194 where Smil claims that "diets of several hundred million people are appreciably enriched by consumption of hunted and collected wild animal species" (apart from fish). Alas, overhunting and habitat destruction have made this statement obsolete. Only in the most remote and thinly populated areas — the Subarctic, the Australian outback, the inner Amazon — do people get significant game meat today. Much more typical is the Yucatan Peninsula where game was a staple food as recently as a generation ago, but now is virtually nonexistent.

Another place where one might question Smil is his section on desertification. He says "...there is little doubt that virtually all early estimates have greatly overestimated the impact of desertification, mainly because they mistook the cyclical nature of these changes for steady degradation.... Desert margins contribute relatively little to global food supply..." (p. 76) There are problems with both these claims. The cyclic waxing and waning of the Sahara against the Sahel was underestimated in the late 20th century, but this does not *greatly* change the estimates. Overgrazing, deforestation, and overcultivation have been devastating. There are too many thousand photographs of "climate change" stopping short at a barbed-wire fence or a reserve border (see e.g. the magnificent collection in Jacobs 1995, or Charco 1999) to make "climate change" a believable explanation of the world's desertification. I have personally seen thousands of cases, on four continents, of a desert landscape giving way—at a fence or other barrier—to a three-foot stand of lush grass or a dense brushland. This can take place on large scales: Even the rather thin protection that Israel gives the Negev has now made Israel's national border quite visible in satellite photographs.

The same could be said for erosion. Smil correctly celebrates the really amazing strides against soil erosion that have been made in the United States, Europe, and some other places, and concludes that soil erosion is not of major concern. Yet he is surely familiar enough with China to know the catastrophic state of erosion there. Perhaps he is less familiar with India and the dry parts of Africa. Clearly he is less familiar with Mexico and Latin America. Of course, there is very little good information on many of these areas, but what we have — and what anyone can see on the ground or from the air — is quite disturbing.

Here, as in some other cases, Smil tends to assume that "no news is good news." This assumption stands on somewhat believable ground when Smil notes that many national statistics understate production. (Maya subsistence farming in western Quintana Roo produce tens of thousands of tons of maize and fruit a year, none of which gets counted in national statistics.) However, the assumption is hard to credit when soil erosion is at issue. Here, the human tendency is the other way: to overlook and underestimate. Satellite pictures could improve our understanding, if we knew enough about interpreting them.

So much for over-optimism — Smil's one lapse into under-optimism is in precisely our area. Smil seems only slightly aware of the enormous potential of underutilized and under-researched crops and cultivation systems, to say nothing of wild plants that could be cultivated. All readers of this journal will have their own pet examples and the cumulative total thereof (were we to pool our knowledge) would surely be enough to feed the world a few times over. Possibilities for expansion range from relatively well-known systems like Maya mixed orchards and Spanish olive groves to exotic potential crops like California's tarweeds and meadowfoam, and from well-known but undervalued animals like guinea pigs to outside cases like oryx and addax antelopes.

But is there a chance that all these measures will be adopted? Is Smil right, or will the catastrophists prove all too correct in the end?

It is well to remember that, although "on average" the world is doing well, the most dreadful fantasies of the catastrophists are now the reality in many countries. These include Ethiopia, Eritrea, Sudan, Somalia, the entire Sahel, and several other African countries, as well as Afghanistan, Uzbekistan, parts of Kazakhstan and Ukraine, North Korea, Haiti, and many more. These suffer from dense and fast-growing populations, collapse of food production, desertification (*not* caused by climate change!), lack of education and research, and, often, other environmental catastrophes, from endemic warfare to Chernobyl. It is noteworthy, but hardly surprising, that the most environmentally devastated countries are also the countries with the worst food problems.

Conversely, the successes of Europe have gone beyond the wildest dreams of the optimists. Zero population growth and lavishly abundant food are accompanied by rapid improvement in the environmental outlook, as green consciousness spreads across the continent. Spain and Portugal are notable among countries that have seen explosive growth in production and income while actually improving (at least locally) their environments.

What accounts for these differences? The conventional wisdom provides us with three possibilities, all obviously wrong. First, most common among environ-

mentalists and still not uncommon among developers, is the idea that "capitalism" is the source of all evil. This clearly does not account for the above picture. Among other things, many environmentalists seem to think that the rich nations are environmentally more trashed than the poor ones, because of high consumption. This is not the case. To see really ravaged environments, one needs to go to such localities as Uzbekistan, Ethiopia, or China. It is the most productive, food-exporting countries that also do the best by their environments. Second, there is the reverse view: Capitalism is what the world needs; socialism is the evil. This fails to account for ongoing and worsening problems of countries that have enthusiastically bought into capitalism and accepted IMF discipline, including most of Latin America and southeast Asia. Third is the idea that dependency and globalization are the culprits. If this were so, we would expect to find countries very tightly enmeshed in the dependency end of the global economy, such as Mexico, Taiwan, South Korea, and Thailand, to be the poor ones. They are not; it is the most isolated countries, such as Ethiopia, Somalia, Bhutan, and Laos, which are the worst off.

There is one simple predictor. Strong yet democratic governments with a strong tradition of accountability are always associated with progress in both food production and environmental awareness. Scandinavia and the Low Countries are examples. Spain, Portugal, Greece and Hungary prove the point by rapidly developing food production and (except possibly in Greece) environmental awareness in the wake of democratization. Weak yet authoritarian governments are at the opposite pole, characterizing the sad examples listed above. A change from democracy to chaos or authoritarian rule accompanies environmental decline (Malaysia, Indonesia, Pakistan), which eventually must lead to food production failure (Guatemala, El Salvador, and elsewhere). It would seem that this correlation should be studied systematically by those interested in the problem. It has more to tell us than either the global optimists or the global catastrophists.

Smil ends his book with a look at China, a country he knows extremely well. Here he crosses swords with Lester Brown whose book *Who Will Feed China? Wake-up Call for a Small Planet* (1995) made the catastrophist case in lurid detail. They both work from very similar factual bases, and (as I know from my own independent research on China) they are both quite reasonable in their interpretations of the data. The difference between them is really over something they never discuss: The leadership China has and will have. Brown assumes that China's leadership will continue to be as it is now. At present, the leaders do not seriously address environmental problems that might limit future food production, and they routinely imprison those who raise the issue. Smil evidently hopes and trusts that a new generation will have new ideas.

Indeed, it appears that Smil's cautious optimism, Brown's worries (see also Brown et al. 2000), or the extreme optimism of the irrepressible and delightfully outrageous Libertarian Ronald Bailey (2000), have much less to do with the facts than with their take on human nature. They all say surprisingly similar things about what we are doing, what we can do, and what we need to do, *technologically*. They even have similar political views, seeing governments as far too prone to hinder rather than help. The difference is that Brown sees governments as inevi-

table and frequently prone to act as they do in Sudan and Afghanistan. Smil looks at the governments of Europe and Canada, and hopes. Bailey dreams of abolishing government altogether.

One wishes Bailey were right. If only people, released from the bonds of the State, would work together for love and profit. Unfortunately, the world is the way it is. I know Bailey is wrong. I hope Smil is right. But if I had to bet money, I'd bet with Brown.

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THE JAGUARS OF ALTAR Q, COPÁN, HONDURAS: FAUNAL ANALYSIS, ARCHAEOLOGY, AND ECOLOGY

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ABSTRACT.—An excavation at Copán, Honduras, a Late Classic Maya site, revealed the ritual cache of bones of at least fourteen big cats associated with Altar Q. Several of the large cats were identified as jaguar, *Panthera onca*. Preliminary analysis showed that the animals were in good health at the time of their deaths. All but one were adults. Tail fans of several species of birds accompanied the feline bones. Associated with the crypt of the felines were the smaller tomb burials of two macaws, *Ara* sp. The authors conclude that it is unlikely that all the jaguars were procured locally because of environmental constraints.

Keywords: Maya archaeology, zooarchaeology, jaguar, Copán, ritual

RESUMEN.—La excavacion del escondite des huesos felinos en el sitio Maya con la fecha de clasico tardio en Copan, Honduras, ha revelado un entieramiento des los huesos de catorce jaguares, *Panthera onca*, y otros gatos grandes, asociados con el Altar Q. El analisis ha mostrado que los animales estaban saludables quando murieron. Todos menos uno que eran adultos. Los huesos de los jaguares estaban acompanados por unos abanicos de cola de varios pajaros. Los huesos de dos arcangas, *Ara* sp., han sido descubiertos en dos peque(os tumbas cerca de la cripta de los jaguares. Los autors concluyen que no es possible que los jaguares fueron obtinidos en el valle de Copan porque del constre(imientos cercaniá.

RÉSUMÉ.—L'excavation ‡ Copán, Honduras, un site Maya de Classique Tardif , a revelé un enterrement rituel des ossments de, au moins seis *Panthera onca*, quatorze chats grands, associés avec l'Altar Q. L'analys des ossments a monstré que les animaux etaint en bon santé au temps du mort. Il y a un jeune et trieze adults dans l'assemblage. Les ventails de la queue de les oiseaux a accompagné les ossments des chats grands. Associés avec le crypt des les animeaux il y ont deux petites enterrements de les deux oisieux, *Ara* sp. Les auteurs ont conclué que ce n'etait pas possible pour les jaguars Ítre obtiner dans le vallée de Copán parce que des contraintes d'environnment.

INTRODUCTION

The discovery of an offertory cache of feline bones yielded an exciting glimpse of ancient Maya ritual behavior to archaeologists. Feline bones filled the masonry crypt to the east of Altar Q at Copán, Honduras, an altar whose sides bear high relief portraits of the sixteen rulers of Copán's Classic Period dynasty. The cache at the foot of Altar Q contained the remains of at least fourteen large felines, two macaws, and the tail fans of seven other birds. This is a report of the discovery and preliminary analysis of the offertory complex associated with Altar Q and Structure 10L 16 in the Acropolis area of the Main Group. Jeffrey Stomper, then a graduate student under the supervision of Dr. William Fash, the Director of the Copán Acropolis Archaeological Project instituted under the auspices of the government of Honduras, excavated the offertory complex in 1988. The offering consisted of a sealed crypt containing the remains of at least 14 large felines, including *Panthera onca*, and macaws (*Ara* sp.) associated with a stone altar on a low, round platform that was placed on the central axis of the western side of Structure 10L 16 in the Main Group at Copán.

Until now, the evidence that large felines were involved in Maya ritual has consisted of skeletons of single animals and portions of skeletons of cats buried in ritual contexts (Pohl 1983, 1990). Landa (Tozzer 1941) discussed animal sacrifices stating that animals were used in rituals and were sacrificed. They were presented to the gods either alive or not, sometimes dismembered but also whole (Tozzer 1941). The cache at Copán is the largest cache of felidae bones discovered by Maya archaeologists to date.

JAGUAR SYMBOLISM

Maya art and iconography are rich with depictions of jaguars. The same is true of other Mesoamerican civilizations. Copán, Palenque, Uxmal, and Tikal are among the lowland Maya sites where jaguars are featured prominently (Morley, Brainerd, and Sharer 1983; Spinden 1975; Tozzer and Glover 1910). Spinden (1975) considered them second only to the snake in symbolic importance to the Maya. Coe (1972) pointed out the links between rulers and jaguars and the separation of king and commoner in native Mesoamerican religions. He further remarked on the antiquity of the jaguar as a religious icon and its ties to Mesoamerican religions and the ruling lineage (Coe 1972).

Images of jaguars frequently decorate ceramics recovered from Maya sites, appearing on a variety of vessels. On these, men often wear clothes with jaguar markings or jaguar pelts (Spinden 1975: 149). Many times jaguar symbolism is part of a ritual or religious context on vessels, such as one from Altar de Sacrificios. On this vessel, the ruler of Yaxchilan is dressed in jaguar skin trousers, mitts made of jaguar paws complete with claws, and a jaguar headdress. A second figure in jaguar regalia is near that has the arms, hands, tail and feet of the jaguar on a human body (Saunders 1989: 146).

The jaguar epitomized two different kinds of strength to the Maya. The jaguar motif was associated with the underworld and its supernatural power and also with physical strength. The association with physical strength derived from the

fact that jaguars are powerful, nocturnal hunters. Ideas of the supernatural power of the jaguar arose from the early totemic tradition of Mesoamerica and the jaguar ***nagual's*** (spiritual co-essence) relationship to the shaman's power. Possession of supernatural power and physical strength was important to Maya rulers because their political power rested on their ability to act as a priestly bridge between the ancestors, the underworld, and the living world (Schele and Freidel 1990).

Maya artists juxtaposed rulers and warriors with jaguar symbolism in art. Strength and prowess of combat were required of both the ruler and the warrior but especially of the ruler. A fearsome beast of the tropical forest, the jaguar personified a dual symbolism: control of the supernatural, a necessary power for Maya kings, and the physical prowess needed by the successful warrior (Saunders 1989; Hassig 1985).

Mesoamerican cultures from Olmec to Aztec revered the jaguar. The Olmec associated jaguars with shamanic power and filled their art with images of were-jaguars. The Aztecs linked the jaguar to war, sacrifice, and royalty (Saunders 1989: 150; Hassig 1985). Furthermore, they associated jaguars with jade, rain, and fertility (Saunders 1989). At the time of the Spanish conquest, Aztec (*Mexica*) traders routinely transported pelts and live animals from outlying parts of the empire to the capital. Pictures of both live animals and pelts appear on trade and tribute lists of goods moving from Soconusco, the colonial province located on the coastal plain of the state of Chiapas, Mexico, to the Aztec Empire (Voorhies 1989).

Relicts of this symbolism are found today in remote areas of Central America, Mexico, and South America. Jaguar symbolism is most visible in masks and ceremonies performed in isolated villages. Wearing a jaguar mask transforms the wearer into a new creature that combines animal, human, and supernatural qualities (Saunders 1989). Thus, the jaguar is an ancient and potent symbol permeating native cultures of Mexico, Central, and South America.

ARCHAEOLOGY

As part of the first season's work of the Copán Acropolis Archaeological Project, William Fash conducted preliminary investigations of Structure 10L-16 and the adjacent Plaza areas in 1988 (Fash 1991; Agurcia, Stone and Stomper 1989). During the spring of that year, excavations at the site of the western base of Structure 10L-16 and Altar Q were in progress, supervised by Jeffery Stomper and veteran local excavator, Ismael González. Stomper concentrated the initial excavations on the area in front of and beneath Altar Q, anticipating finding the dedicatory offering or other remains of associated rituals at that locus. Other examples of dedicatory caches had been found either directly in front of or underneath altars and stelae elsewhere at Copán (Stromsvik 1941). An area was marked off directly west of the altar and excavated to a depth of 120 cm. Fearing for the integrity of the trench if he dug between the stone supports that uphold Altar Q, Stomper elected instead to tunnel beneath the altar from the eastern sidewall of the same pit. This mini-tunnel excavation beneath the altar produced no evidence of a cache, nor was there any evidence that the area under the altar had been disturbed.

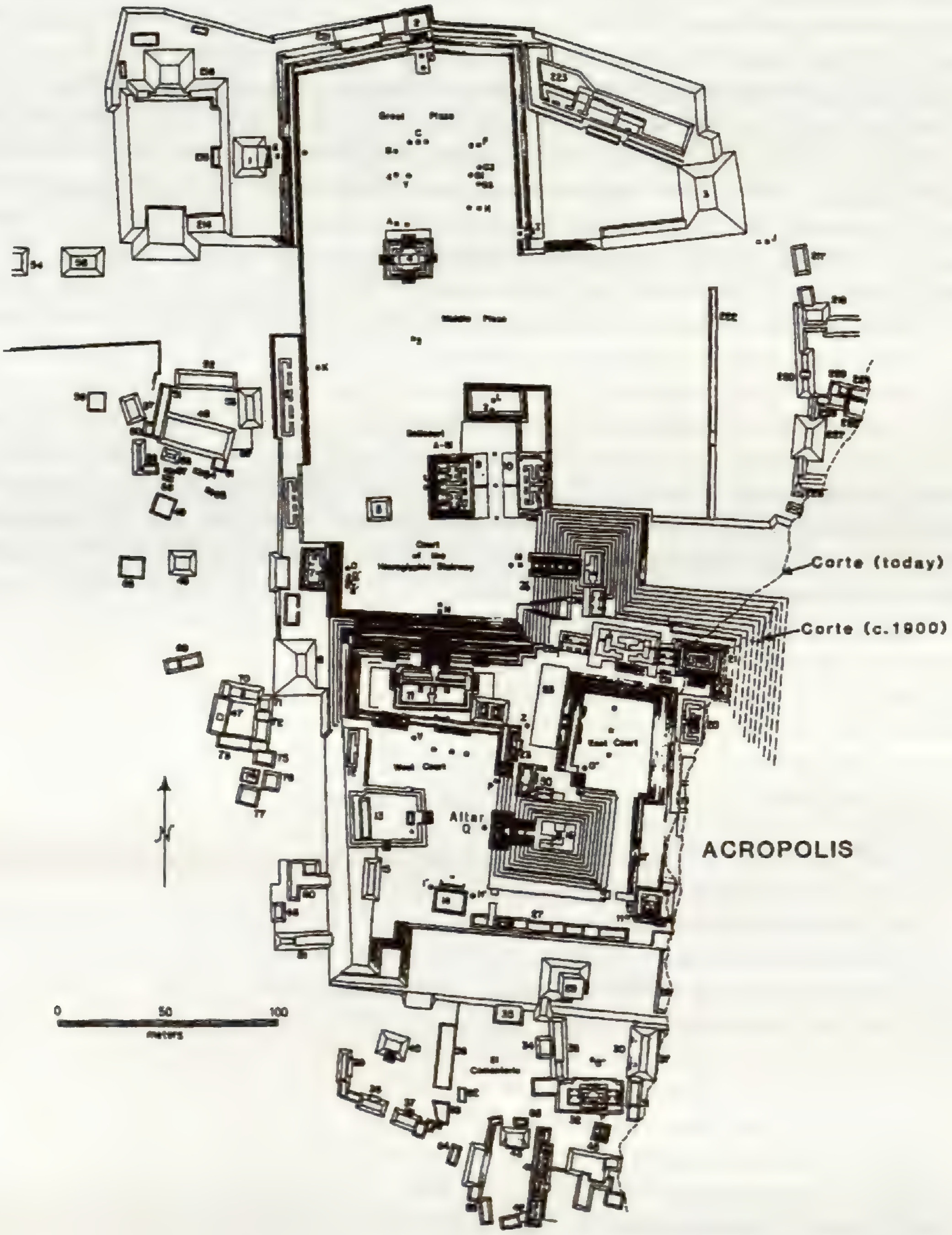

FIGURE 1.—The East Court, Main Group, Copán, Honduras. Supplied by William and Barbara Fash.

Stomper began another pit that mirrored the location of the previous one. Immediately, he found two features. The first was a plain, round altar, CPN 13470, with a diameter of 36 cm. Altars such as these were used as stands for incense burners elsewhere in Copán during the Late Classic period (Fash 1983:464). The second feature was what appeared to be several rough slabs of stone, Feature 8, in a line below the level of the last plaza floor. The excavation was expanded to uncover the extent of this feature.

The capstones were aligned in a north-south direction, sloping from east to west, and covering the masonry crypt that contained the animal bones. Probing between the stones revealed a hollow area approximately 1.3 m deep and at least 1m wide. When Stomper removed the capstones, he found that debris from places where the walls had caved in filled the crypt. The crypt, measuring 131 cm long and 48 cm wide, had walls of eight courses of finely cut building stone rising to a height of 117 cm.

Within the crypt, the excavators found animal bones. The removal of the first level of bones revealed an irregular intrusion of lime plaster in parts of the cist. Excavation of this layer revealed that more bones were embedded in the layer of plaster with still more bones below it. These layers were removed in the plaster matrix in large sections and kept separated. Stomper continued excavations into the fill under the cist to a depth of 3 m under the plaza level. He recovered only 7 fragments of ceramics from under the cist. Approximately 319 cm below the original cist floor, the excavators uncovered an earlier plaster floor of the West Court. Excavations were terminated at this point.

Two small shafts adjacent to the cist were also uncovered just outside the northeast and southeast corners of the cist. The inside of the roughly square shafts measured 22 cm on each side. At the bottom of one shaft were nine whole prismatic obsidian bladelets and parts of two others. Located 25 cm above the obsidian were the bones of a medium-sized bird. The second shaft also contained the bones of a bird but no obsidian. Nothing else was found.

Stomper excavated the entire area between Altar Q and Structure L10-16, revealing a round platform of small, faced stones two courses high in some places. Unfortunately, the whole platform was not preserved. Located in the center of the platform was an oval stone with a smooth upper surface, repeatedly charred by fire. Resting on the top of the platform was a small, highly polished fragment of jade. The area around the platform yielded incensario fragments, a ceramic incense burner. In an adjacent area to the west of the platform just below the level of the last plaza floor, a small cache of obsidian lancets was found.

FAUNAL ANALYSIS

During the summer of 1988, the faunal material was identified and recorded, and a preliminary report was filed at the Central Office of the Project in Copán (Ballinger 1988). The bones were counted, sorted into skeletal elements, and examined for pathological conditions and anomalies.[1] Ballinger used weight-bearing bones of the appendages to determine the minimum number of individuals (MNI) because weight-bearing bones have large areas of dense, compact bone, and, hence, tend to be better preserved (Brain 1981). Left and right elements were identified

and counted. Ballinger matched the bones by size or age to determine if they belonged to a single individual (Chaplain 1971). Juveniles were identified by the lack of epiphyseal closure. The analyst ignored most of the fragments because time was limited. The largest MNI of the elements was then determined as the MNI for the species (Klein and Cruz-Uribe 1984). Actual bone counts were made at Copán. Photographs of the best preserved crania were taken for later identification. Final identification to species level was made in the Zooarchaeology Lab at Indiana University, where a comparative collection is housed.

Analysis was done under field conditions without the use of a comparative collection or manuals commonly used by faunal analysts. Neither a comparative collection nor library resources were available in 1988 at the Copán laboratory to aid in identification. Ballinger took notes supplemented with photographs and sketches. The initial identification of the bones as feline resulted from her examination of the teeth, crania, scapulae, and femora while in Honduras.[2]

Condition of the Bones.—Burial in a closed crypt resulted in good preservation. Although the bones were subjected to natural decay, they were protected from some of the taphonomic processes that radically change relationships between skeletal elements (Lyman 1982). Thus, while many of the bones were not articulated, they were close to the position in which they were placed in the crypt. The crypt walls kept them from being dispersed after burial. They were also protected from water and heat, the two most powerful agents in bone dissolution (von Endt and Ortner 1980). The bones were dry and chalky but retained their shapes, so skeletal elements were easily identified. Exfoliation was present on some of the bones but most of them were well preserved.

An assessment of pathological lesions was made on the bones that had minimal flaking on them. The bones of the second level, excavated as a unit and curated as a unit, allowed Ballinger to determine the position of the jaguars of the second level in the crypt by the association of skeletal elements. The heads of some had been laid over the rear legs and feet of others.

Results of the Faunal Analysis.—The MNI of the felines was at least 14. This number is conservative because the analyst was unable to perform a complete examination of all the faunal material. Ballinger found that many of the bones found in the crypt were *Panthera onca*. Differences in jaguars and puma lie in cranial morphology. According to Olsen (1968), jaguar crania have a sagittal concavity on the superior aspect of the cranium that rises to a pronounced lambdoidal crest that gives a slight s-shaped curve to the jaguar's skull. The posterior crest gives the jaguar cranium a squared off appearance and the skull appears longer and more rectangular. The puma, however, has an oval skull lacking the massive, posterior cresting. Crania of jaguars and puma are similar in their anterior aspects and teeth but differ in the posterior aspect. It is the posterior features on the crania the discriminate between the species. The more complete crania from the crypt have distinctive nuchal robusticity and a more elongated architecture of the jaguar. Although there is not enough cranial material remaining to account for 14 jaguars, an estimated 6 animals in the assemblage were *Panthera onca*. The others are felines but remain to be positively identified as jaguar. The remaining bone in the assemblage is bird bone and a few intrusive rodent bones.

The bones of the felines are very similar in size, indicating that the animals were similar in age and sex. They were also healthy animals. Assessment of indicators of general health routinely surveyed by investigators: cortical thickness, osteoporosis, and the frequency and severity of periosteal reactions, lesions of reactive bone growth resulting from localized and systemic infections, demonstrated that the cats were free from these pathological conditions that commonly mark the bones and indicate a decline in health status.

Large cats are prone to bone diseases in captivity. Osteoporosis, thinning of the bones, is a problem for large felines in zoos. It results from inactivity, too little protein, old age, and metabolic disorders (Fowler 1986). Caged felidae are also highly susceptible to metabolic bone disease that results in a rickets-like bowing of the long bones (Fowler 1986). The cortices of the bones were thick and only one periosteal reaction was found. The single periosteal reaction was on the hind foot of one animal and had fused two metatarsals. Appendicular bones were robust with prominent muscle markings, and had no sign of rickets-like bowing.

No cut marks, dismembering marks, or skinning marks were found on the feline bones that were examined. The removal of pelts results in a characteristic pattern of skinning marks. Skinning for pelts often makes cuts ringing the lower metapodial where the knife has circled the ankle or wrist to loosen the skin. Carpals, tarsals, and the bones of the digits are then removed with the pelt and, thus, are missing from the assemblage. Ballinger found no evidence that the pelts were removed after death. Further work, however, should include careful examination of the bones for skinning and other butchering marks.

In addition, the vertebrae must be examined. Ballinger concluded that crania may have been disposed of separately for some of the cats. The paucity of cranial fragments compared to the amount of post-cranial material leads Ballinger to the conclusion that crania may have been disposed of separately. Further analysis may reveal cut marks on the first or second cervical vertebrae if the heads were removed before burial.

The avian bones in the assemblage were collected from two places, the small shafts adjacent to the crypt and from the crypt itself. The bones of an adult macaw, *Ara* sp., were found in each shaft. Both of the macaw skeletons were missing the pygostyle, the bone to which the tail fan attaches. Two pygostyles of the correct size were recovered from the crypt, possibly the ones missing from the birds in the shafts. The pygostyle is a fragile bone, however, and may have been destroyed by postmortem diagenesis. There are seven other pygostyles from other unidentified birds in the crypt. Three of these probably are the same species. The other four are two matching sets and may represent two more species. Lack of a comparative collection precluded the complete identification of the avian bones. In all, nine tail fans were buried with the jaguars. Other bird bones buried in the crypt included a caudal vertebra, a fragment of a tarsometarsus, a fragment of a proximal radius, a rib fragment, and two phalanges. All of these remain unidentified. There were no signs of rodent gnawing or cut marks on the avian bones.

Preservation of the macaw bones differed for the two shafts. Burial 1 lacks cranial bones. The head may have been removed at the time of death but the remains were too broken to properly check for cut marks. The remains of more than

one bird may be present in the second shaft. The bones removed from the second shaft have more fragments of long bone and cranium than Burial 2. Differences between the two shafts' contents, however, may have been affected the microenvironments of each shaft. Ballinger identified the macaws by the presence of the beak in Burial 2 and a comparison of the two birds. It was clear that post-cranially they were the same (Hargrave 1970). However, all of the avian bone should be reanalyzed with a comparative collection at hand.

In summary, a MNI of at least fourteen large felidae, some of them *Panthera onca*, were identified from the bones in the crypt. The animals were healthy with no indications of longterm protein deficiency or inactivity. Accompanying the felines were the tailfans of nine birds, including two macaws. No evidence of butchering or mode of death was found in this analysis. A full study of the feline bones may reveal sex and age differences, less obvious evidence of disease, and the mode of death of the animals. Similarly, comparison of the avian material to comparative skeletal collections may reveal the species of the unidentified material.

DISCUSSION

Natural History and Ecology of the Jaguar.—The jaguar (*Panthera onca*), is the largest of three species of spotted cat native to Central America (Burton 1987). Classed as a big cat, the jaguar has a shoulder height ranging from 110-155 cm (Burton 1987). The jaguar prefers a forest habitat but can live in savanna environments if there is enough brush cover. They also live in slightly arid areas. Good swimmers and climbers, jaguars are primarily nocturnal feeders, sleeping during the middle of the day (Burton 1987).

Few investigators have studied the natural history of the jaguar in the wild so most information comes from zoo studies. Many of the details about breeding patterns come from studies of zoo animals. Jaguars are very easy to raise in captivity. They breed easily and can live on two or three pounds of meat a day, according to David Ruhter,[3] former Curator of Large Animals, Houston Zoo (Personal communication via telephone, 1994). Less is known about their behavior in the wild. Large felidae are long-lived animals whose prey is normally about half their body weight (Sunquist and Sunquist 1989; Gittleman 1984; Packer 1986). They usually need large areas in which to forage and, except for lions, are solitary.

Today, the jaguar has adapted to more crowded habitats in Central America. In 1983, Rabinowitz and Nottingham (1986) tracked the movements of nine jaguars in Belize. The authors found that the home ranges of the jaguars overlapped but that as long as prey was available, they remained on them, avoiding each other. Analysis of scat determined that in Belize jaguars feed on seventeen species of prey (Rabinowitz and Nottingham 1986). This is consistent with reports from other areas to the south that jaguars feed on diverse prey: capybara, fish, peccary, and alligator (Ewer 1973). Generally, jaguars feed nocturnally but the female in the Belize study changed her feeding pattern to the daytime in order to exploit cattle as prey. This study suggests that the jaguar is flexible and able to adopt new habits as needed to survive (Rabinowitz and Nottingham 1986).

Naturalists do not know much about the behavior of the puma in Central America. *Felis concolor* occupies a wider range of habitats than the jaguar, ranging from mountains to jungles to deserts (Ewer 1973). The puma is slightly smaller than the jaguar. Puma diet is omnivorous in tropical climates where they consume several types of rodents, fish, and other small game. The main component of their diet is deer and domesticated farm animals, although they have demonstrated behavior flexibility in the selection of prey species.

The jaguar and the puma are in almost direct competition in Central America because of the similarity in size, habits, and diet. Puma are also nocturnal feeders unless forced to feed at other times. They are known to live near home ranges of jaguars (Rabinowitz and Nottingham 1986) in Belize, but in the North American west, their ranges are larger and do not overlap.

The ecology of the jaguar has important implications for explanations of how the Maya acquired at least fourteen big cats for ritual use. Rue (1987) states that by the Late Classic, the valley was heavily deforested resulting in a loss of habitat for tropical forest animals. If, however, enough brushy areas still existed in the valley, jaguars could have survived there, given the presence of adequate prey. In general, species that live in savanna or parkland areas have larger populations than forest living animals (Berkoff et al. 1984), thus deforestation could lead to a slight increase in the population of cats in the valley. Jaguars have demonstrated their ability to survive crowded conditions and the ability to change feeding schedules. It is highly probably that they survived in a mosaic environment of parkland and brush.

Ultimately, however, access to prey governs population size. A deforested but still brushy area could have supported sufficient deer and other species of prey to, in turn, support a small jaguar population. Similarly, a mosaic of brush and cleared spaces will support a white-tailed deer (*Odocoileus virginianus*) population whereas closed canopy forest will not (Smith 1975). Deer have small home ranges, often living near humans and thriving. Historically, deer have been an important part of Maya subsistence (Mandujano and Rico-Gray 1991) and only recently have declined in importance as numbers decreased. Both brocket deer and white-tailed deer feed in cleared areas of new growth near fields because tender shoots are present there. There also may be fewer insects in young forest (Mandujano and Rico-Gray 1991). Mandujano and Rico-Gray (1991) remarked that the decline of Yucatan's deer population was directly attributed to over-hunting and loss of habitat, a relatively new situation. Population decline was exacerbated by the loss of native farming methods that provided browse each season after the fields were burned, cleared, and farmers severely trimmed brushy growth in and around the milpas. This growth sprouted anew with the rains. Pohl (1994) proposed that Copanecos were very likely to have raised deer in and around their homes and fields in the valley.

Other animals available as prey are Brocket deer (*Mazama* sp.) and peccary (*Tayassu tayacu*). Both would have done well in this open, brushy habitat. Brocket deer browse on the same kinds of plants as white-tailed deer: tender twigs, shoots, and leaves of a variety of herbaceous plants and fruits. The peccary is omnivorous, living in a variety of tropical habitats, including forests and dry savannas

(Lawlor 1979). Smaller prey, such as paca, agouti, and armadillo are native to the area and can live in brushy environments.

The Copán Valley could have supported a small population of big cats even if it were partially deforested. Whether it could have supported a population large enough to provide at least 14 adult big cats from local sources is another question. The Copán Valley is comprised of 26 square miles of territory. Of that, the heavily populated Copán pocket would have been too urban-like for jaguars or pumas to live there. Game such as deer would have been drawn to the areas surrounding fields further out rather than the kitchen gardens closer to the central site. Big cats would have lived farther out from the Main Group at Copán.

Normally big cats have large home ranges of 15 square miles. If we assume that crowding has limited the size of the home range a home to 5 square miles, the Copán Valley would only provide ranges for five jaguars at a time. Avoidance behavior as demonstrated in Belize would not make it possible for more animals to survive unless even with prey populations of very high density. Thus, the large number of felines found in the crypt most likely resulted from a combination of trade, hunting, and hand raising.

THE OFFERTORY COMPLEX AND THE JAGUAR BURIAL

Yax Pasah, the last ruler of Copán, had begun an aggressive new building program by raising Temple 11 and making significant additions to the West Court, where Altar Q is located including Altar Q (Fash 1991). The altar is an illustration of the succession of the last ruling dynasty of the polity. Along the sides of the altar the names sixteen rulers are inscribed beginning with Yax Ku'k Mo' (Blue or First Quetzel Macaw) and ending with Yax Pasah. Yax Pasah, by his choice of iconography for the West Court, indicated its relationship with the underworld, Xilbalba, and, thus, to his ancestors (Schele and Freidel 1990).

Yax Pasah faced serious problems during his reign, including deforestation, a population that was shrinking, and a diminution of his power (Fash 1994). Schele and Freidel (1990) note that most of his monuments state the cosmic sanction of his rule, and hypothesize that his reign was marked by crises. His impressive sacrifice and building program may have been an attempt to restore Copán to its previous place in the hierarchy of major sites.

Structure 10L-16 was the final product of the remodeling in the West Court. The jaguar burial occurred at this time as a ceremonial cache for the dedication of the last version of Structure L10-16. The Copenecos placed Altar Q at the base of this structure. Yax Pasah buried at least 14 big cats in the crypt associated with Altar Q. Once the people of Copán placed the felines in the crypt, tail fans of birds were placed there, and the crypt was then covered with three capstones. A small, round, carved altar was placed next to it directly between the two shafts. A final plaza floor was then laid, covering the capstones. Jaguars and other spotted cats had an unknown but important ritual significance at Copán. Pohl (1994) remarks that while skeletons of spotted cats were often cached in ritual contexts by the Maya, Copán has more such caches than any other site. All of these have so far been found in elite contexts. Pohl (1994) considers them a measure of the high

position of the site of Copán in the Maya hierarchy. The inclusion of macaws was ritually significant but their meaning is less clear. The name of the dynastic founder was macaw. Macaws occur frequently in the decoration of public ritual space at Copán, especially on the ball court.

Questions of where the jaguars came from and how they were killed remain unanswered. The ecological conditions and size (over 75 km) of the Late Classic Copán Valley could have supported a small population of jaguars or pumas even if partially deforested. It was not, however, large enough to provide 13 adult and one semi-adult large cat. David Ruhter (Personal communication 1994) suggested that the easiest way to assemble that many jaguars would be to gather kits in the spring and raise them by hand. There is evidence that jaguar kits were given as gifts. A vase from Tikal shows a turbaned figure holding a kit and presenting it to the ruler (Culbert 1993).

The feline bones, however, presented no evidence of long-term inactivity or protein deficiency, indicating that the Copanecos had taken good care of the animals and that their caged time was short. At this time, it is impossible to determine whether the animals were raised by hand or captured as adults.

We can only speculate about how the jaguars met their fates. Preliminary examination revealed no cut marks on the bones to indicate that the jaguars had been skinned or dismembered. A more complete analysis of the bones may reveal skinning marks leading to determination of their modes of death. The presence of crania and numerous tarsals and metatarsals, carpals and metacarpals indicate that some heads and feet were not removed. Often on ceramic vessels, individuals are portrayed dressed in jaguar pelts with heads and paws still attached (Coe 1973; Schele and Miller 1986; Kerr and Kerr 1989). It appears that the valuable and ideologically significant skins were left on the animals.

CONCLUSION

Jaguars could have lived in the Copán Valley even after deforestation if a brushy, mosaic environment was present. The size of the valley, the amount of tilled fields, and even with deer management, the amount of prey limited the number of jaguars and pumas that were living there. The flexibility of feeding patterns and the presence of small home ranges as demonstrated by modern jaguars in Belize indicate that jaguar populations in the past could have adjusted to smaller, overlapping ranges close to humans populations without undue stress. Jaguars would have been in direct competition with the Maya for scarce protein given their reliance on a maize-based diet.

The lack of disease and stress indicators on the bones of the jaguars indicates that the bones are the remains of generally healthy animals that had not been captive for a long time. These animals had no chronic metabolic diseases that cause bowing of the leg bones, no osteoporosis, and only one periosteal reaction. Furthermore, all but one of the animals were adults with full epiphyseal closure. This indicates that healthy, adult cats were chosen for the cache. The cats could have been kept in good condition for as long as four to six months by being fed two or so turkeys each day (David Ruhter, Personal communication 1994).

Hopkins (1992), in her work on the animals bones removed from the Cenote of Sacrifice at Chichen Itza, argues against the assumption that the jaguar bones found at Chichen were solely the result of sacrifice because there are too many other reasons that the bones could have been deposited in the cenote. At Copán, the bones clearly are in a ritual context, one that is repeated many times at the site. The cache of the feline and bird bones represented a significant gift to the people of Copán. By placing his sacrifice in the West Court with all of its symbols of the underworld, Yax Pasach hoped that a continuous connection with the ancestors and the jaguars' supernatural power would be forged. Thus, homage was paid to garner the aid of ancestors and gods to keep the polity strong and growing when many Maya cities were falling into decline. It was to no avail. Shortly after this, the people of Copán ceased to erect dated monuments and the population of the central valley declined.

Future work should include analysis of the assemblage of feline bones. Measurements of the bones and assessment of small differences between the jaguar and the puma should be made. The analysis should also contain reconstruction of crania and pelves, where possible. Finally, a close examination for cut marks and any other butchering marks should be carried out.

NOTES

[1] The jaguar bones are curated at the Central Laboratory in Copán Ruines, Honduras. This is also where the field reports, preliminary reports, manuscripts, theses, and dissertations are housed. The archives at Copán include drawings, photos, and a small library and are a good resource for investigators.

[2] Two students of Wm. Fash have examined the collection of animal bones but I have not been able to contact them by publication time.

[3] David Ruhter was curator of large animals at the Houston Zoo when I contacted him. He has since moved out of state and the personnel department at the Zoo would not release his address to me.

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El Bosque Mediterráneo en el Norte de África. Jesús Charco. Agencia Española de Cooperación Internacional, Madrid (Avenida Reyes Católicos, 4. 28040 Madrid, Spain). 1999. Pp. 370. Many color and black-and-white photographs, maps, figures, tables. No price quoted. ISBN 84-7232-825-2.

This magisterial work is far enough outside the normal scanning pattern of Western Hemisphere readers that it needs some attention here. Charco has produced one of the most splendid studies of a Third World region's forests and its conservation problems. North Africa still has large forested areas in the Atlas Mountains and a few scraps remain in the coastal lowlands of Morocco, Algeria and Tunisia. However, the vast majority of the historic forest area is gone, almost all the rest is degraded, and deforestation is proceeding.

The forests of the Atlas are largely evergreen (cedar, pine, a few fir) higher up and largely oak lower down. The oaks are diverse, each species having its preferred habitat. Some fascinating conifers occur at low altitudes; *Tetraclinis articulata*, a strange cypress-like plant, covers thousands of hectares. Fragments of wild olive forests and riparian groves exist. Among the most fascinating trees is the argan (*Argania spinosa*), endemic to Morocco (almost exclusively in the southwest), valuable for timber, fuel, forage, and the high-quality oil of the fruit. Its value has protected it, but not well enough; like all other trees, it is under assault. It grows in a strange subtropical forest at the west end of the Atlas, where its usual cohorts are other endemics or are Canary Island species that still have a tiny mainland foothold.

The book is arranged by forest type, as defined by dominant tree. More specifically, the system is the "phytosociology" of Braun-Blanquet and followers, which is almost universal in European botany though relatively little known in the Western Hemisphere. For each forest type, common species are indicated — not only other trees, but also shrubs, herbs, and fauna. Rare and endangered plants and animals receive attention. Ethnobotanists will find full accounts of the uses of the trees and of the varying levels of preservation that they have received.

Northwest Africa has known agriculture and stock raising for 7,000 years. For 3,000 of those years, states and cities have been present. The impact on the forest, especially the lowland forest, has been among the most severe found anywhere in the world. The Roman Empire exploited the forests and exterminated the native elephant. After its fall, unstable governments and an emphasis on animal husbandry led to progressive decline. The twentieth century saw the extermination of the lion, the Nile crocodile, and most other large animals, though a few leopards may survive. Deer have been kept available by stocking. The larger birds are similarly impacted. Even small animals are often endangered.

On the other hand, Charco's extremely thorough searches through the lands in question give us a more hopeful picture than the earlier classic works of Mikesell (1961) and McNeill (1992). He and others have found remote and cliff-girt areas where magnificent forests still cover thousands of hectares. Astonishing relictive forests are still turning up in remote areas. A stand of dragontrees (*Dracaena draco*), previously believed endemic to the Canary Islands, was found in southwest Morocco as recently as 1995.

Charco is emphatic in pointing out that human agency has done the damage. On the other hand, local systems have developed reasonably good ways of managing much of the landscape. Cultivation between standing trees, nondestructive

cork extraction from cork oaks, rational though thorough utilization of argan trees, careful terracing of slopes, and many other devices reduced the human impact. Religious beliefs and sanctions preserved forests in many places. The problem today is that very rapid population growth has gone along with equally rapid modernization, complete with roads, big dams, unregulated logging, and the rest of the litany. Yet economic growth, which would have brought pressures for more rational exploitation of resources, remains slow and uneven in the region. In addition, Algeria has been racked by warfare.

Recently, a revisionist view blames desertification on climate change. Charco provides many photographs of forests surviving in cemeteries, sacred sites, and reserves, and regenerating with wild abandon in fenced-off plots. It is clear that the damage is indeed the result of logging, firewood collection, and, above all, stock rearing — not climate change. The result, in loss of valuable plant products alone, has been catastrophic. To this one may add the loss of topsoil; much former forest is now eroded to bare rock. Water runs off where once it seeped into groundwater. Wildlife and wild herbs are gone. The economy has lost an incalculable amount of wealth. It is truly staggering to contemplate how much richer the three countries would be if they had been able to exploit the forests in anything like a sustainable manner. The time is not too late; protection would allow the forests to recover, eventually, in much of their former habitat.

To a Californian, this book is thought-provoking (at the very least). The southern half of California is a near-perfect geographic match for northwest Africa. We too are using our environment in a destructive, non-sustainable way. The same desertification that affects North Africa is not far off, unless dramatic changes occur. One wonders if North Africa's poverty and instability will be duplicated here.

This book is illustrated with hundreds of photographs, charts, diagrams, and tables. Several color photographs are presented for every forest type. The quality of these pictures is high. They are taken to show the vegetation and its fate, not just to fill up space with something "pretty" (as is the case in all too many books). The book lacks an index, but excellent organization and the many visual aids make up for that.

In short, this is a book that everyone interested in forest use and management will want to see. Have no fear if your Spanish is limited; the photographs speak for themselves.

This and many other ecological and ethnobotanical works are available from the Libreria Agricola, Fernando VI, 2. 28004 Madrid — a bookstore worth knowing, especially if (like me) you can order books for your university library.

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PERCEPTION AND MANAGEMENT OF CASSAVA (*MANIHOT ESCULENTA* CRANTZ) DIVERSITY AMONG MAKUSHI AMERINDIANS OF GUYANA (SOUTH AMERICA)

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ABSTRACT.—This article presents the ways in which Makushi subsistence economy and its farming practices, food preparations, cultural knowledge and social processes have all played a role in bringing cassava varietal and genetic diversity into existence. After comparing cassava varietal diversity among the Makushi of Guyana with that found in the rest of Amazonia, the authors discuss the genetic implications of traditional management and show that evolution in populations of domesticated cassava results from the combined action of natural and human selection. Various socio-cultural factors exercising selective pressure, in particular the exchange of planting material between farmers and the conceptual opposition of seedlings and plants coming from vegetative propagation, are examined. The approach adopted, which integrates indigenous botanical knowledge, elements of plant genetics and ecology, emphasises that diversity cannot be reduced to a finite stock of well defined, separate entities called varieties, but is, rather, a fluid and evolving process by which farm-grown varieties are continuously gained and lost.

Key words: Cassava, *Manihot esculenta*, Makushi Amerindians, Guyana, traditional agriculture

RESUMEN.—Este artículo presenta la manera en que la economia de subsistencia de los Malushi y las prácticas de cultivo, la preparación de las comidas, el conocimiento cultural y los mecanismos sociales han contribuído a una importante diversidád genética y varietal de la yuca. Después de un análisis comparativo de la diversidád de la yuca cultivada por los Makushi de Guyana con la que se encuentra en el resto de la Amazonia, el artículo discute sobre la simplicaciones genéticas de las prácticas de cultivo tradicionales, y muestra que que la evolución de las poblaciones de yuca cultivada es la consecuencia de la acción combinada

de la selección natural y la selección humana. Varios factores socio-culturales implicados en la selección, en particular los intercambios de estacas entre los cultivadores y la oposición conceptual entre la planta nacida de semilla y la planta obtenida por estaca són examinados. La integración de los conocimientos botánicos indígenos, de elementos de genética y de ecología muestra que la diversidád, lejos de estar reducida a un conjunto finito de entitades determinadas llamadas variedades, es al contrario un proceso fluido y dinámico, por el cual las variedades cultivadas son continuamente adquiridas y perdiddas.

RÉSUMÉ.—Cet article présente la façon dont l'économie de subsistance des Makushi ainsi que les pratiques de culture, la préparation des mets, les connaissances culturelles et les mécanismes sociaux ont tous contribué à une importante diversité variétale et génétique du manioc. Après une analyse comparative de la diversité variétale du manioc chez les Makushi de Guyana avec celle que l'on trouve dans le reste de l'Amazonie, l'article discute les implications génétiques des pratiques de culture traditionnelles et montre que l'évolution de populations de manioc domestiqué est la conséquence de l'action combinée de la sélection naturelle et la sélection humaine. Plusieurs facteurs socioculturels impliqués dans la sélection, en particulier les échanges de boutures entre les cultivateurs et l'opposition conceptuelle entre plante issue de graine et plante issue de multiplication végétative sont examinés. L'approche adoptée, qui intègre les connaissances botaniques indigènes, des éléments de génétique et d'écologie, souligne que la diversité, loin d'être réduite à un stock fini d'entités déterminées appelées variétés, est au contraire un processus fluide et dynamique par lequel les variétés cultivées sont continuellement acquises et perdues.

INTRODUCTION

While present concerns about the conservation of genetic resources have led to the reassessment of the human side of plant/people interactions, the questioning of the division between natural and artificial mechanisms of selection has prompted a growing number of researchers to pay particular attention to the ways in which people affect plant genetics (Salick 1995). These developments, which have given rise to a new type of economic botany that integrates ecological and evolutionary dimensions in the reinterpretation of plant domestication, cultivation and management, have resulted in renewed interest in traditional farming systems, known for maintaining high levels of biological diversity (Boster 1983; Salick and Merrick 1990; Salick 1992a; Brush et al. 1994). Traditional farming systems have so far been studied by geneticists, who have attempted to assess the level of genetic diversity found in collections of cultivated plants, including varieties, and by social scientists, who have carried out extensive ethnological surveys. However, only a few studies have tried to connect both genetic and ethnobiological aspects of the maintenance of varietal diversity (e.g., Quiros et al. 1990; Zimmerer 1991; Salick 1992b; Louette et al. 1997; Souza et al. 1997; Emperaire et al. 1998).

The overall objective of our investigation of cassava (*Manihot esculenta* Crantz, Euphorbiaceae) is to apply an integrative approach combining ethnological, ecological and genetic data in order to understand how the biological diversity of this cultivated plant is traditionally managed and maintained. For this, we have cho-

sen to study bitter cassava cultivation in a Makushi community of the North Rupununi savannas of Guyana, South America (Figure 1). Some of the results of our genetic studies are now available (Elias et al. in press); ecological studies are still in progress. The specific objective of this paper is to document the cultural knowledge and practices that have brought the genetic diversity of cassava into

FIGURE 1.—Map of Guyana, showing the location of the Makushi communities where the study was conducted.

existence. This information on the cultural environment, combined with information on ecology, is essential to the interpretation of population genetics and evolutionary patterns (Elias et al. in press).

Bitter cassava, characterised by high cyanogenic-glucoside content of the tuberous roots, is the staple crop in the Amazon, where it has been cultivated for more than 3000 years (Renvoize 1972). Most cassava research to date has been conducted in the Northwest Amazon (see for example Hugh-Jones 1978; Boster 1984a; Dufour 1985, 1988; Chernela 1987; Van der Hammen 1992; Salick et al. 1997), where the cultivation and processing of (mainly bitter) cassava have been meticulously described. Rival (in press) presents a comparison of cassava cultivation and processing between northwest Amazonian groups and Amerindians of the Guyana shield.

METHODS

Site of study.–Our study was mainly based in Rewa, a small Makushi community of the North Rupununi in Guyana, situated at the confluence of the rivers Rewa and Rupununi (forest area), 50 km WSW of Apoteri (4°02′ N, 58°35′ W). Marianne Elias spent 9 months over 3 field sessions in the Rupununi (April 1997, February – May 1998, September – December 1998); Laura Rival spent 5 weeks (2 field sessions in April 1997 and April 1998); and Doyle McKey spent one month (one field session in October 1998). In April 1998, there were 162 people living in Rewa (including three Wapishana men, six Wapishana women, and two Patamona women), forming 27 households. Because of its small size and relative isolation, Rewa is less subject to commercial and political pressures than savanna communities. Other Makushi villages, located in the savannah area, were also visited. Concerning the farming system, no major differences were found between these villages and Rewa, which can thus be considered representative of the Makushi farming system in this region.

Collection of ethnographical data.–Our methods involved observations, participation in farming practices and food processing, open discussions, structured and semi-structured interviews and questionnaires. Symbolic and other cultural data were collected as part of a participatory research programme led by Laura Rival and involving the close collaboration of two remunerated Makushi women researchers. We tried to work with as many farmers as possible; however, three female farmers (ages: 22, 35, 52) and two male farmers (ages: 41, 50) were identified as our main informants. As almost everybody in Rewa is fluent in English or Portuguese; discussions and interview were conducted in these languages, including some Makushi words for critical points. Bilingual villagers helped us with people who spoke only Makushi. One villager in Rewa and two villagers in the savannah area helped us with Makushi spelling.

Assessment of varietal diversity and of its distribution.–Varietal diversity was assessed by first asking farmers to bring leaves of every kind of cassava they cultivate, then by visiting farms and interviewing farmers. To estimate the equitability of diversity distribution among cassava farmers we used the index of equitability, which

is often applied to estimate the "evenness" component of the diversity of biological assemblages.

It is calculated as follows : $E = \frac{\sum_i p_i . \ln p_i}{\ln S}$, where $p_i = \frac{n_i}{S}$, $S = \sum_i n_i$, and n_i are the numbers of households that cultivate variety *i* (respectively, the number of varieties owned by household *i*).

MAKUSHI CASSAVA FARMING TODAY

The Makushi, a Carib-speaking group, live in the Rio Branco-Rupununi region, which is a region politically divided between Brazil (Roraima State) and Guyana (Region 9). There are approximately 20,000 Makushi today, of whom 7,000 live in Guyana (CIR 1993). Historical records of Makushi presence in the Rio Branco-Rupununi region date back to the early part of the 18th century (Rivière 1963; CIDR 1989; Farage 1991; Hemming 1994, 1995; Santilli 1994). With cattle ranching expanding at the turn of the century, they experienced increased land shortages and pressure to work as domestic servants or cowboys, and many of them left the Roraima hills in Brazil for the Rupununi savannas of what is now Guyana (Farage 1991), where they can still be found, living in relatively small communities, headed by a captain or "toushau." Makushi families historically traded manufactured goods for cassava and cassava derivatives, particularly farine, a meal made of dried granules of grated cassava (Farabee 1924; Diniz 1966; Farage 1991). White settlers needed the Makushi as much for their agricultural products as they did for their labour force, and there is little doubt that such demands modified the indigenous agricultural system. Such influence accentuated the importance of horticulture over hunting and gathering, and reinforced the tendency towards sedentarisation in nucleated villages. If, like many other Amerindian groups, the Makushi had traditionally produced cassava surpluses to prepare fermented drinks for festive occasions, the condemnation of such politico-ritual activities by missionaries, the new trade opportunities, and additional factors linked to interethnic contacts, led to the utilisation of cassava surpluses to make farine for sale, a trend which has influenced the choice of cultivated varieties.

Bitter cassava cultivation is central to Guyanese Makushi slash-and-burn agriculture, which is still directed toward subsistence, rather than market, production. Many varieties of bitter cassava are maintained (Makushi Research Unit 1996), and the diet is supplemented by other starchy crops such as yams (*Dioscorea* spp.), corn (*Zea mays* L.), sweet potato (*Ipomoea batatas* (L.) Lam), sweet cassava (*Manihot esculenta*), plantains (*Musa paradisiaca* L.), or vegetables such as pumpkin (*Cucurbita maxima* Duch. ex Lam.), shallots (*Allium cepa* 'aggregatum' L.) and onions (*Allium cepa* 'cepa' L.), or fruits such as watermelon (*Citrullus lanatus* [Thunb.] Mansf.), as well as fish and meat (game and cattle).

Agricultural activities are conditioned by climatic and edaphic factors. Wet (from May to September) and dry (from November to March) seasons are pronounced and interspersed with brief transitional periods. Two factors make savannah soils particularly unsuitable for crop cultivation. In addition to being particularly infertile, they are subjected to weather extremes; they are almost en-

tirely flooded during the rainy season, and parched under a scorching sun during the dry season. This explains why people traditionally lived in forest galleries along main rivers, where soils remain moist throughout the year, and used the savannah mainly for seasonal hunting.

With the rare exception of plantain and cotton farms, Makushi farms are, on the whole, bitter cassava farms. Sweet cassava, yams, sweet potatoes, plantains, pumpkin or watermelon are sometimes inter-cropped with bitter cassava, but these crops are rather marginal. Bitter cassava is consumed daily as farine (***u'wi***), cassava bread (***kai***), fermented drinks (***parakîrî***, ***kasiri*** and ***wo'***), casereep (***kumasi***), a black, thick paste used throughout Guyana to cook meat and fish, and, finally, starch tapioca (***imu yanasa***) or porridge (Figure 2).

Each year during the dry season, households clear new farms (ranging from 400 m_ to more than one hectare) in old fallows or secondary forest, that is, on land that has already been used in the past to cultivate cassava. As the main problem in farm management is protection of crops from predators and fluctuating climate, risk aversion, particularly the risk of flooding and of leaf-cutter ant invasion, seems to play a greater role than soil fertility in the choice of farm sites.

Clearing a new farm (***mîî ya'tî***) is considered hard work, and is exclusively a male activity. It was traditionally performed by a man with the help of his relatives and friends (***mayu***), in exchange for food or drinks (***parakîrî*** or ***wo'***). Cooperation in forest clearing now tends to be restricted to immediate kin, for example, father and son. New farms are burnt (***mîî po'tî***) in March or April, just before the first rains. Fire is propagated with lit kokerite (*Attalea regia* [Anderson]) fronds, a process difficult to control and which may lead to forest fires and crop

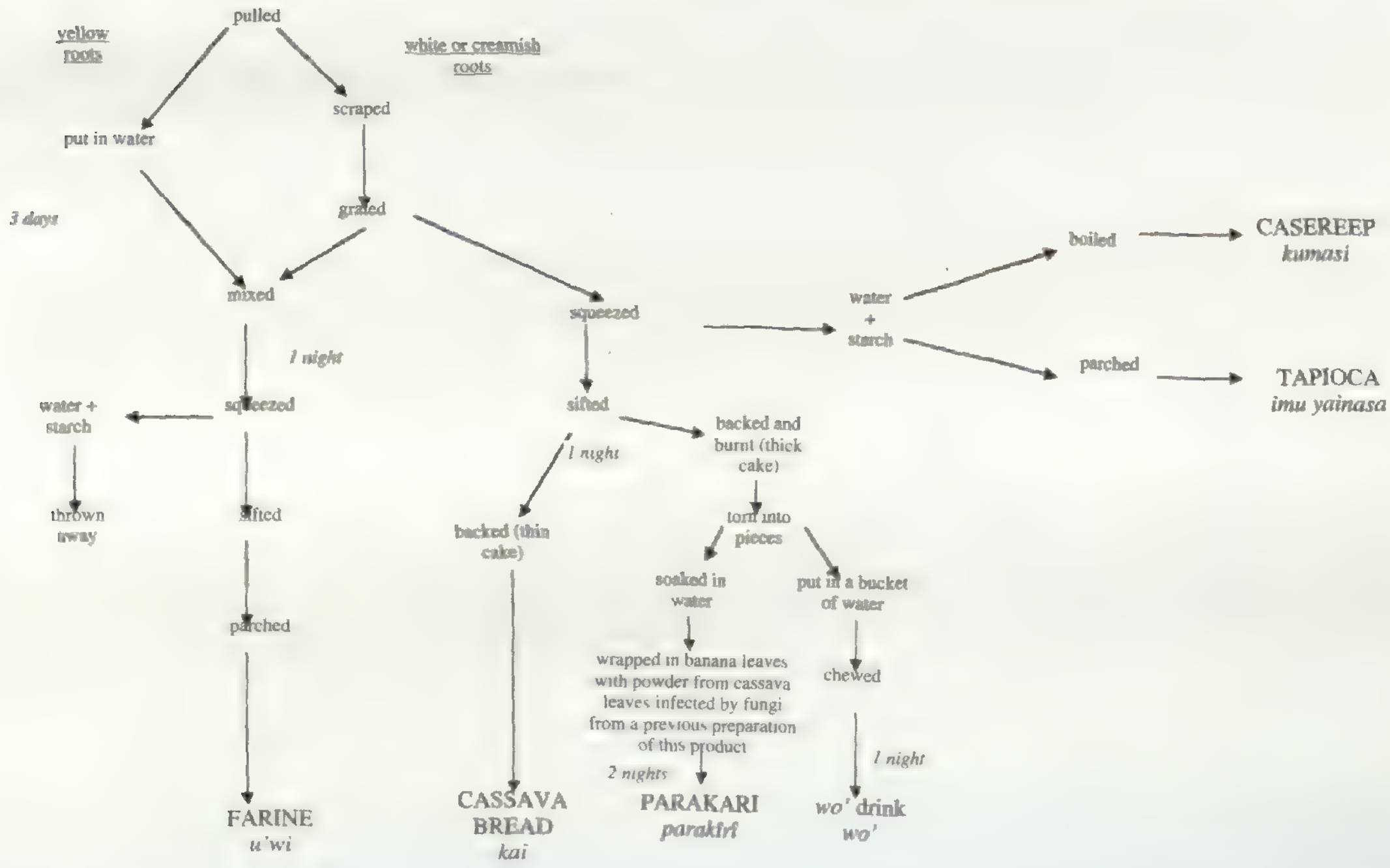

FIGURE 2.—Processing and products made of cassava by Makushi Amerindians.

losses when weather conditions are particularly dry. Ground cleaning (***mîî kui ma***), the third stage in preparing a new cassava farm, is undertaken by the entire household, children included. The male farmer hoes (***ya nu mîî***) the field, and shapes the soil into mounds (locally known as "banks"), in which cuttings (locally called "cassava sticks", ***kîsera*** in Makushi) are planted (soil mounding, a practice rather uncommon in Amazonia, is also found in the Upper Xingu [Carneiro 1961]).

Female farmers, sometimes accompanied by their children, divide the long stems of freshly harvested cassava into cuttings. Although they store long stems in shady places or keep them for weeks, slightly buried in the ground before using them as planting material, farmers prefer to prepare cuttings directly from a living plant. Moreover, the selection of cuttings depends on whether a plant is healthy and whether it has produced a generous harvest of roots. Cutting the stems is a woman's work, but planting is usually done by men, although this is not always the case in other villages (Mary Riley, University of Illinois at Chicago, USA, personal communication). Three to five cuttings of the same variety are planted together in each mound, pointing to the west. Although most people are aware that cuttings planted eastward grow as well as those pointing westward, they still maintain that a westward orientation protects the plant from the sun and favours its growth. There may be a connection between this belief and the common Makushi practice of burying corpses with the feet pointing east, head west, and the face looking to the rising sun (data collected by Laura Rival in Massara, April 1997). Another common practice observed by Laura Rival in the field, and aimed at encouraging growth and tuber production, is to plant a magical plant (generically known as ***bina*** in Guyana) in the middle of the field, or to chew the root of such a plant, and spit it over the mounds (see also Makushi Research Unit 1996).

The time it takes a farmer to plant a new cassava farm depends on his availability, and on how many stems the household has in stock; it thus varies greatly from farm to farm, and from individual to individual. Some farmers plant cassava every day for a week, and then stop for two or three weeks before continuing. As a result, several months can separate the youngest and the oldest plants in a single farm. This practice, as well as the planting of varieties with different maturation rates, ensures a constant supply of harvestable roots throughout the year. Cassava roots are harvested on average nine months after planting (range: 4 months to 2 years), and the crop requires little care during this period. A first crop does not generally require weeding more than three times, but women may perform spot weeding every time they harvest roots (both weeding and harvesting are female tasks).

Roots are harvested when and as they are needed. Stems of freshly harvested cassava are sometimes replanted in mounds hoed again for what the Makushi call the "second crop." More commonly, they are taken to a new farm, where the best cuttings are selected and planted. The surplus is stored, hidden under kokerite fronds, or planted in tight bundles at the edge of the farm. Some may be given to neighbours, relatives or friends. Unused stems stored in bundles also grow and, if the weather is not too dry, develop tuberous roots nine months after. These roots are harvested, but the stems are usually discarded, being used as planting material only if the farmer is desperately short of cuttings.

After harvest, first crop farms are planted with a second crop of cassava. Second crop farms require greater weeding efforts, and their productivity is lesser. When harvested, they are not generally hoed again and replanted, except if the parcel cleared for the first crop is located in primary rainforest or old secondary forest, where the rich, deep forest soil allows for a third, and even sometimes a fourth crop. Abandoned farms are soon covered with fast growing pioneer vegetation. Old farms are left fallow for two to twenty years, or more. Although farm land is not privately owned, old fallows are customarily left for the use of the families who first cultivated them.

As in most Amazonian societies, cassava processing is the responsibility of women, and food intimately connected with gender specialisation. However, it is not uncommon to see a man helping his wife making edible products out of bitter cassava, which contains a high concentration of cyanogenic glucosides and must be detoxified before consumption. Roots are scraped, and the skin and inner peel (except in the preparation of ***parakîrî*** and ***wo'***) removed. They are then washed and grated. The grated pulp is squeezed in the long plaited cassava sleeve press, known in Guyana as matapi (***tinki***). To make farine, women first mix fresh grated cassava with roots that have fermented for three days, and then squeeze the mixture. The half-dry pulp is then used for preparing the final products (Figure 2). This process ensures that most of cyanide is removed (Dufour 1989, 1995)

To sum up, the farming system so far described is broadly similar to those found among other Amazonian bitter cassava farmers (see in particular Dole 1963, 1978; Yde 1965; Diniz 1966; Grenand and Haxaire 1977; Hugh-Jones 1978, 1979; Carneiro 1983; Dufour 1983; Chernela 1987; Mowat 1989; Van der Hammen 1992; Grenand 1993; Emperaire et al. 1998). We are fully aware that the farming system we have studied may be a recent development linked to sedentarisation. We suspect, for instance, that the present shortage of farmland has resulted in sharp reduction of fallow periods. This shortage, dramatic in the savannah, where farmers have to walk for hours or paddle for several days to reach their farms, is beginning to affect Rewa as well. Another consequence of sedentarisation is that farms must last longer, so people tend to select varieties that can stay in the ground longer, such as, for example, the popular "white man stick" that remains harvestable two years after planting.

CASSAVA DIVERSITY AND ITS PERCEPTION BY THE MAKUSHI

Cassava diversity in one Makushi village.– Cassava varieties are distributed in farms either in a structured pattern (i.e. planted in contiguous monovarietal patches), or at random, the latter distribution being more frequent. Every variety has a Makushi name, of which the English translation is usually known. In Rewa, we collected 86 different names of cassava varieties (Table 1), corresponding to 76 varieties (while some varieties were given different names by different farmers, some farmers knew several varieties under a single name). Varieties that farmers were unable to name were not included in the survey. Each household owns on average 16 varieties (Table 1). Varieties differ in their frequency of representation among households. While some are shared by almost all farmers (for example, ***paranakîrî pîye*** and

kuraatuma pîye), others are owned by only a few, or even by a single person (for example, ***oronkî pîye*** and ***dominko ye***). The equitability index for cassava varieties is 0.63 (it would be equal to 1 if all varieties had the same frequency in the village), and 0.52 for households (it would be equal to 1 if all the households had the same number of varieties). No one in Rewa has an accurate or exhaustive knowledge of the varietal diversity present in the village.

Sweet cassava is planted either in the farm, together with bitter varieties (but the two types of roots are not mixed, as sweet cassava is not cultivated for the same purpose), or in the kitchen garden next to the house. Farmers say that sweet cassava roots develop more slowly than bitter ones, and that the plant grows taller. Four different types of sweet cassava, all called ***kana*** as opposed to ***kîse*** (bitter cassava), are grown in Rewa. They all have white roots, and are generically referred to with English names ("brown stick," "four months," "eighteen months," or "white stick"). The lack of a proper Makushi name confirms that sweet cassava is not regarded as "real" cassava; like yam or sweet potatoes, its place in Makushi diet is secondary (Makushi Research Unit 1996). Semi-quantitative tests based on a colorimetric method using alkaline picrate (Williams and Edwards 1980) confirmed that all varieties designed as bitter by the Makushi have a high cyanide content, whereas so-called sweet varieties have a low cyanide content (Elias unpublished data, see also Dufour 1988).

Perception of bitter cassava diversity.– Makushi lore includes several myths referring to cassava and its origin, as well as to Cassava Mother (***kîsera yan***), the master spirit that owns the plant, looks after its well being, and ensures good harvests (Rival in press). Although myths are complex cultural representations that cannot be reduced to one single dimension or message, Makushi myths relating to cassava clearly convey the idea that this plant exists first and foremost as a cultivated, that is, a domesticated or cultural plant, whose inalterable blueprint is the master spirit Cassava Mother, and whose origin relates to the transformation of a human body. Wild cassava[1] is represented as a degenerated cultivar escaped from gardens, which has stopped producing tuberous roots, because it now grows in non-cultivated (i.e. non-cultural) spaces, such as hill tops in the savannah.

Taxonomy.–Savanna-dwelling farmers of mixed origin (i.e. of Makushi and Black, locally known as "dougler"), and Makushi who have no direct knowledge of cassava cultivation, recognise only three kinds of cassava: yellow, cream and white varieties. They differentiate them by color and use, as cassava bread is made with the roots of white varieties, and farine with the roots of yellow varieties. The first morphological trait mentioned by a farmer is the color of the root, and its intensity. Three main categories are actually differentiated: yellow types, creamy types (which non-farmers confuse with yellow types), and white types. This classification, also found among other groups (Emperaire et al. 1998), plays a determinant role in evolutionary terms. This may explain why Makushi people tend to underestimate their varietal diversity, and why outsiders are only aware of differences in root color.

Named varieties constitute the second, and more ambiguous, level of classification. Varieties are named after animals, plants, objects, dishes, qualities, and

TABLE 1.—Cassava varieties found in Rewa, and their distribution among 24 families.

Makushi names	English names	AM	NE	WE	VA	DP	JM	TA	RE	JE	MA	AE	DH	FW	JA	CS	EK	NI	WA	JH	PH	CH	LE	ZP	HS
ainis pîye	Inez stick				x										x										x
aknes pîye	agnes stick					x																			
akuriu ye	agouti stick					x			x										x			x			
amilton ye	Hamilton stick			x																					
amo'ko pîye =	grand father st. =																								
danal pîye	Danal stick	x				x			x		x									x					
amuru pîye	thick stick		x		x													x	x					x	x
ankela pîye	Angela stick																					x			
anra pîye	crane stick	x	x		x	x			x		x		x	x		x		x	x		x	x	x		x
dominko ye	Domingo stick																					x			
eti pîye	Eddie stick				x	x							x				x		x		x	x			x
eni pîye	Eni stick				x																				
esekwipo ye	Essequibo st.				x															x		x			
isman pîye =	Isman stick =																								
sandra pîye =	Sandra stick =																								
amuru pîye ?	thick stick ?				x	x			x						x	x			x		x		x		
kaima pîye =	pumpkin stick =																								
eri pîye	Ely stick	x	x		x	x	x	x		x	x		x	x			x		x	x			x		x
kanaima ye	jombie stick				x						x														x
karmani pîye	Carmani stick						x																		
kasiri pîye	kashiri stick		x										x										x		x
kediam pîye	Kediam stick							x																	
kini' pîye (2 types) =	dry stick =																								
reni pîye	Reni stick	x	x		x	x		x	x	x	x		x	x		x	x	x	x			x	x		x
ko'ko pîye	grand mother stick																					x			
kraiwa pîye	brazilian stick		x			x	x				x			x	x				x		x				x
kari'na pîye	Carib stick				x																	x			
kompani pîye	company stick									x															
krompî pîye	?					x																			
kumia ye	fish stick																					x			

Makushi names	English names	AM	NE	WE	VA	DP	JM	TA	RE	JE	MA	AE	DH	FW	JA	CS	EK	NI	WA	JH	PH	CH	LE	ZP	HS
kunani pîye	fish poison st.					x							x												x
kuraatuma pîye (2 types)	caiman stick	x	x	x	x	x	x	x		x	x		x	x	x	x	x	x	x	x		x	x	x	x
kurarî pîye	curral stick	x	x		x			x		x	x			x			x			x	x	x	x		
kuraswa pîye* = *selia pîye* = *waimko pîye	Crash Water st = Celia stick = Waimko st.	x	x			x		x		x	x		x		x				x		x		x		x
lio pîye	Lio stick																		x						x
mai pîye	bitter stick	x						x		x			x						x				x		
maka pîye	maggah stick									x															
makarpon ye	Makar pond stick																			x					
marasî pîye	marudi stick				x			x			x								x						
mauri pîye	Mauri stick								x			x												x	
meekoro pîye	black man stick		x		x		x				x	x	x	x		x		x							
mepriko ye	Elfrida stick					x										x				x					
omano pîye	Omano stick																					x			
oronkî pîye	bamboo stick						x																		
paapa ye	father stick						x	x		x															
pakaima ye	buffalo stick							x			x														
pali pîye* = *kaiwan pîye	Bali stick = fat boy st		x	x	x			x			x		x					x	x					x	x
papîro ye	Pablo stick	x			x			x		x			x		x		x						x		x
parakîrî pîye	parakari stick		x							x									x		x				
paranakîrî pîye	white man stick	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
paranakîrî pîye itakon ye* = *naman pîye	white man stick cousin = Naman stick		x		x					x	x							x	x		x		x		x
paranakîrî pîye perurupe	white man stick seedling				x																				x
pinkîu ye	peccarie stick					x	x				x			x		x							x		x
pîraun pîye	Brown stick																					x			
pîrikwa pîye* = *ipo ye	bird stick = sweet stick	x	x		x	x		x		x	x		x	x		x		x				x	x		x

Table 1 (continued)

Makushi names	English names	AM	NE	WE	VA	DP	JM	TA	RE	JE	MA	AE	DH	FW	JA	CS	EK	NI	WA	JH	PH	CH	LE	ZP	HS
pîrori pîye	Pearl stick					x																			
prona pîye	brown stick				x						x														
rekî pîye	thick stick																								x
rikîtun pîye	black stick			x																					
rora pîye	green stick	x						x			x														
sakari pîye	Zaccharie stick							x																	
saketa pîye	Sagda stick																					x			
saprî pîye	fine fish stick	x						x		x	x				x										
seruak pîye	3 months stick						x									x									
siya pîye	Shea stick		x					x		x	x			x			x		x						x
siment pîye	cement stick		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		x
siwal pîye	Sea Wall stick					x													x						
sona pîye	Jona stick		x		x						x														
supra pîye	cutlass stick		x		x			x		x	x	x	x	x		x	x				x	x	x		x
tare'kîya pîmoi	water turtlle egg																								
pîye = suyu ye =	stick = yellow stick =																								
five month stick =	5 months st =																								
u'wi pîye ?	farine stick ?				x	x	x	x			x			x					x	x		x			x
tari ye	black potatoes stick																								x
tikîri pîye	?									x			x												
toni pîye	Tony stick												x												
urakasa ye	pigeon stick										x														x
usariu ye	deer stick					x																			
u'wi pîye	farine stick		x		x	x	x		x		x	x	x	x	x		x		x						
uyara pîye	macaw stick (cassava heart)									x														x	
waakîri pîye	I love stick		x																						
walakîse pîye	Walax stick												x												
wo' ye	drink stick	x	x	x	x														x	x					x
total number of varieties : 76		14	22	7	28	22	12	21	9	20	27	6	20	15	10	12	11	10	23	11	11	19	16	7	27

Table 1 (continued).

according to the place of origin or the person from whom cuttings were obtained. Names derived from animals, plants, objects, dishes, and qualities are said to be more authentic and traditional than those based on Christian names and toponyms, with which they often overlap. For instance, the real name of "Ely stick" is "pumpkin stick," but as the farmer who received it from Mrs. Ely had forgotten the real name, she chose to call the new variety after Mrs. Ely. Almost all the inhabitants of Rewa speak both Makushi and English, but bilingualism does not seem to affect the naming system, given that all Makushi names have an English translation. We were told that it is the husband's, rather than the wife's, responsibility to give names to new varieties. On the whole, the Makushi naming system is similar to those used by many other traditional Amazonian groups (Salick et al. 1997; Emperaire et al. 1998).

Visits to various farms with different informants allowed us to confirm that farmers use the taxonomic classification outlined above fairly consistently. Eight times out of ten, they agree on what name to give to a particular variety. However, since the varietal make-up of each farm is different, a farmer visiting a neighbour's farm may be unable to name some of the varieties. We also detected several cases of synonymy and of homonymy (Table 1). The first genetic analyses, which are the best tools to detect such events, have confirmed these observations (Elias et al. in press).

Accuracy of taxonomy is of great importance in determining evolutionary pressures on cassava, since individual human selection acts on taxonomic units, locally identified as varieties. The fact that generic terms are increasingly used (at least in our informants' perception) may lead to an impoverishment of the highly specific variety vocabulary. For example, a really yellow variety is now commonly referred to by the generic term "farine stick" and a variety hard to grate by the term "dry stick", while an increasing number of varieties are called by the names of those from whom they were obtained. As a result, a farmer may have two or three types of "farine stick," "dry stick," or "Bali stick". However, most farmers can still differentiate among homonymous varieties. They can, for example, distinguish the "dry stick" with broad leaves from the "dry stick" with narrow leaves, and explain these differences accurately to the botanist. But we are not entirely certain that they are able to distinguish two morphologically close varieties with exactly the same properties, or coming from the same place, if they call them by the same name. The consequences of such taxonomic impoverishment are discussed below.

Recognition process.–The Makushi seem to identify their varieties all at once, just as they or we identify people we know. Several farmers told us that they cannot name a variety before checking the appearance and quality of the roots. This instantaneous and integrative recognition process, which appears to depend entirely on the plant phenotype, was first identified by Shigeta (1996), who calls it "face-to-face recognition."

Our hypothesis is that the recognition process operates on the basis of an unconscious hierarchisation of salient characters. This is best illustrated when a plant is hard to identify, because of phenotypic plasticity. The overall aspect of the stem is the first character observed, and the most important for defining the identity of

the plant. The next salient traits are, in decreasing order of importance, the aspect of the leaves, the color of the petiole, the external aspect and color of the root, and, finally, the flowers. These observations are concordant with those of Boster (1985) and of Emperaire et al. (1998).

While certain varieties are preferred for particular uses, there is much functional redundancy among varieties, and there appears to be no practical reason for having so many varieties of bitter cassava. The Makushi seem to enjoy diversity for its own sake, and more for aesthetic and recreational reasons, or out of scientific curiosity, than for security purposes. Our observations corroborate those of Carneiro (1983), who noted that the Kuikuru (Brazil) cannot explain why they have so many varieties; they just have them. Makushi farmers also say that they do not know, that they simply like seeing many different types of cassava in their farms. Like collectors, they seek to cultivate as many varieties as possible. They are driven by a deep-seated curiosity that pushes them to acquire new types continuously, "to try them out." This readiness to experiment has real implications for the structure and dynamics of cassava diversity.

THE DYNAMICS OF DIVERSITY

Cassava diversity is not static, and farmers experience intentional or unintentional losses of varieties, for which they compensate by acquiring new types. As stated before, acquiring new types can also be motivated simply by curiosity. We review here environmental and human selective factors involved in the dynamics of diversity.

Environmental selective factors.–Severe droughts and floods are recurring climatic conditions which can lead to the loss of varieties, and to which Makushi people have learned to adapt. According to our informants and our own observations, exceptionally dry weather such as that caused by El Niño from August 1997 to April 1998 kills recently planted and growing cassava alike. Drought affects root production, and can destroy all the propagation material. Varieties present in low densities, or owned by a few farmers only, are more likely to disappear. The Makushi have therefore developed special planting strategies to protect the cuttings from drought, and, to a lesser extent, flood. Farmers, for example, are careful to keep in the soil cuttings which, at first sight, look dried-out but which will almost certainly sprout again with the first showers. Mounds are reshaped with taller profiles, and replanted with six or eight (instead of four) cuttings to maximise the chances of having at least two well-developing plants in each. The general strategy is to prioritise the long-term reproductive cycle. Rather than saving harvestable roots, farmers try to preserve the stems as "germplasm banks". For this, they look for swampy areas, which are under normal circumstances flooded, and transport their best stems -sometimes over great distances- from their farms to the swamps, to stock them in large bunches there until it rains (Rival 1998).

Whereas cassava varieties in many parts of South America and Africa are seriously affected by diseases (cassava bacterial blight, Boher and Verdier 1995; African cassava mosaic virus, Fauquet and Fargette 1990), varieties in Rewa do not seem to suffer much from disease. However, in 1998, a new plague locally called "white

disease" (***turere***) caused by a small white insect (*Aonidomytilus albus*, Hemiptera: Diaspididae) which kills all affected plants struck all the high forest farms located three hours downriver from the village. One family with downriver farms lost all its cassava varieties.

Farmers seem to have many problems with, and often complain about, herbivores (Table 2). Leaf-cutter ants *Atta* spp. ("acoushi ants", ***kuinan***), which often destroy entire farms, and are very difficult to get rid of, are identified by farmers as the most dangerous predator of cassava. Farmers may decide to abandon a farm altogether, rather than try to eliminate ants. Other herbivores feeding on leaves usually act sporadically, and rarely kill plants. But their predatory activities may nevertheless dramatically affect plant vigour and root production, even causing roots to become watery. Plants that are frequently attacked by herbivores may not be multiplied. The "carelessness" of peccaries and tapirs, which often trample and destroy everything when feeding in a farm, may also lead to variety loss. Farmers do not seem to be aware of any particular herbivore/variety association, and information collected from different farmers regarding perception of varietal resistance was contradictory, which could reflect either strong soil/genotype interaction for resistance, great variability, or lack of interest in this feature.

Human selection.–As a cultivated crop, cassava is under intense human selective pressure. Vegetative propagation allows for the instantaneous selection of phenotypes of interest. Farmers, who can decide whether or not to keep a variety, to a certain extent also control the relative frequency of each variety. If there is no conscious selection for resistance to pests, diseases, or climatic conditions, some varieties will nevertheless be multiplied, whereas others will decrease in frequency. As far as we were able to observe, there is no directional selection on maturity rate either, since farmers need both precocious and late-bearing varieties in order to minimise risk and secure a continuous supply of harvestable roots. As scientists, we were even asked jokingly to invent a new and improved variety that would have such a broad maturity rate spectrum that there would be no need to grow any other variety.

TABLE 2.—Main wild herbivores feeding on cassava in Rewa.

class of herbivore	species	Makushi name	attacked parts	importance of damage
Insects	*Atta* spp. (leaf-cutter ants)	***kuinan***	leaves	+++
	Erinnyis ello (larvae of a sphinx moth)	***arari***	leaves	++
Birds	unidentified	***anakwa***	leaves	+
Mammals	*Mazama americana* (brocket deer)	***usari***	leaves	+
	Dasyprocta agouti (red rumped agouti)	***akuri***	roots	+
	Dasyprocta prymnolopha (black rumped agouti)	***akuri***	roots	+
	Agouti paca (paca)	***urana***	roots	+
	Tayassu pecari (white-lipped peccary)	***pinkî***	roots	+++
	Tayassu tajacu (collared peccary)	***pîraka***	roots	+++
	Tapirus terrestris (tapir)	***waira***	roots	+++

Taking up Boster's (1984a) hypothesis, McKey and Beckerman (1993) suggest that the productivity criteria include many other agronomic features. Human selection for productivity would combine with natural selection for survival and resistance. Like other Amazonian cassava cultivators (Boster 1985; Chernela 1987; Salick et al. 1997; Emperaire et al. 1998), the Makushi consciously select varieties primarily for their productivity. For instance, every household in Rewa has the ***paranakîrî pîye*** ("white man stick") variety, which produces high yields. It is the most frequent variety in 17 of the 24 farms included in our census. Yield is, however, highly variable among farmers and crops. Some varieties can be very productive in the first crop, but do poorly in the second, whereas others, which do not have a very high production in the first crop, do well in the second.

The color of the root is another important criterion for selection. The main dish in traditional Makushi diet is cassava bread made with white varieties. But when ranchers settled in the Rupununi in the 1930s, demand for farine, a staple with which they fed their workers, soared. Farmers responded to the demand by preparing increasing quantities of farine, which is made with yellow varieties, and they also increased the proportion of farine in their own diet, thus multiplying yellow varieties at the expense of white ones. This shift from cassava bread to farine, and from white to yellow varieties, is widely recognised as a recent phenomenon (see in particular Yde 1965). People nevertheless say that they like farine, which is easy to store and process, and that they want yellow forms, hence their eagerness to acquire yellow varieties. Four "really yellow" varieties are found locally, of which at least one is cultivated in great quantities.

Varieties are also selected for their culinary or "processability" properties, but these criteria vary greatly from farmer to farmer. Some women we interviewed prefer watery roots, which are easier to grate, whereas others liked dry roots, richer in starch. Aesthetics also play a role in selection, and a variety with an unusual combination of morphological characters undeniably arouses the farmer's curiosity and interest.

In addition to selecting varieties according to these criteria, farmers also protect rare varieties, thus encouraging frequency-dependent selection. A variety is rarely discarded, even if it is not very productive. Low-yielding, rare varieties are simply kept at low density (i.e. one or two mounds per farm), and this is considered enough to prevent their loss. Farmers explain that they do not like losing varieties, for a "bad" variety sometimes becomes "good" under different conditions. Rare varieties, however, become more vulnerable to loss by direct or natural selection. Finally, farmers lose varieties, not only because of environmental pressures or deliberate choice, but also because of bad space management. As each farm is limited in size and contains a finite number of mounds, there is sometimes no place left for experimental planting, and cuttings of marginal varieties may no longer be available when space becomes available again. If this occurs, the farmer has lost this variety. In sum, conscious human selection on cassava varieties is rather lax; it acts primarily to preserve diversity, rather than to maintain or augment some particular desired traits.

The exchange of cuttings and the management of volunteer plants grown from seedlings, which represent two means of acquiring new varieties or recovering lost ones, greatly contribute to the maintenance of cassava diversity.

Exchange networks. Farmers can recall the origin of all the varieties they have in their farms, no matter how far back they have to go. In former times, when the rule of uxorilocality and bride service was more generally applied, a young husband was expected to cultivate with his wife the farm of his parents-in-law, until his father-in-law gave him the permission to set up his own farm. The young husband would then receive a share of cuttings from his father-in-law, a stock which he complemented with cuttings brought from the farm of his own parents. The young wife would receive cuttings from her mother, sisters, mother-in-law and sisters-in law. The couples we interviewed always specified which varieties were brought into the conjugal farm by the husband, and which by the wife.

It is perhaps because a transfer of cuttings is initiated by request from a farmer in need that farmers so accurately remember the origin of the cuttings they cultivate. The most general term used to express the idea of transfer is "borrowing." A farmer short of planting material or willing to try a new variety asks another farmer for stems, which he or she will "repay" at a later stage with stems of a different variety, or with farine or ***parakîrî*** made with roots from the borrowed varieties. Delayed reciprocity has been observed among other Amerindian groups, such as the Aguaruna (Boster 1986). There is no specified rule on how long after having "borrowed" a farmer must "give back." The only time when transfers are not receiver-initiated, and when there is no pay back, is when a farmer donates cuttings to compensate damages, such as the destruction of part of a neighbour's crops through uncontrolled fire. The exchange of cuttings between closely related kin and neighbours whose farms are contiguous and who still practice a form of shared labour (***mayu***) is less formal and generalised, in the sense that strict reciprocity is not an issue. Only very occasionally will a farmer acquire cuttings of a rare variety by paying with cash, a cutlass, a bicycle or any other trade item. This type of exchange is more likely to occur between unrelated farmers who do not live, and have no family connection, in the village.

Two types of exchanges, one "massive" and the other "occasional," can be distinguished. Farmers who need large amounts of planting material for a new farm borrow cuttings from just a few varieties, which they usually already possess, but not in sufficient quantity. Those who want to try out a variety they do not have in their farm ask for a stem or two while visiting neighbours, friends or relatives. Farmers, who are always keen to acquire new varieties, carefully multiply the trial cuttings until reaching the desired density. The closer the locality from which a new variety originates, the more likely the retention of its real name will be. In contrast, a variety coming from a distant locality may be called after a toponym, for example "Shea stick" or "Crash Water stick."

In contrast with Chernela (1987), who has reported exchanges over an area 465 km wide, most Makushi cutting exchanges (and all massive exchanges) occur within the village community, in particular among immediate neighbours, who are usually related through descent and marriage (unpublished data). As a result, some families never interact, while others are continuously exchanging cuttings. Frequent exchanges between the same families are expected to lead to taxonomic homogenisation (Boster 1986). According to informants, cuttings were not traded across ethnic boundaries in the past, and even inter-village exchanges were -and still are- restricted, which, of course, does not exclude acquisition through war-

fare, looting, and the taking over of another tribe's old farms. Some farmers carefully avoid asking for cuttings, as they derive great prestige from relying on their own stocks, while lavishingly giving away to borrowers. Others, who keep their farms at a distance, never invite visitors, and share only reluctantly, are considered "stingy." Yet others do not dare asking for coveted cuttings, which they surreptitiously pick from the farms of neighbours or hosts (a behaviour which may lead to generalised theft in times of drought and starvation). To summarize, while some families always experience a deficit of planting material, others almost never borrow cuttings. And whereas some share their surpluses generously, others prefer to let their unused bundles of cuttings dry out. When examining the social networks underlying massive exchanges, we soon identified "source" families, whose efficient management of cassava production not only prevented them from experiencing shortages, but also ensured that they usually disposed of sufficient planting material to give away. "Sink" families, in contrast, managed their stocks poorly, often ran out of cuttings for their new farms, and heavily depended on borrowing. "Source" farmers are proud and respected community members, with a higher status than "sink" farmers.

Tepuru pîye. The cassava plant grown from spontaneous seedlings. New varieties are often acquired through the incorporation of volunteer cassava plants grown from seedlings, the products of sexual reproduction, that appear spontaneously in farms (Makushi Research Unit 1996). Although cassava has long been propagated vegetatively, it has retained its ancestral capacity for sexual reproduction. In Makushi farms, most varieties produce flowers, and these produce fruit which dehisce at maturity, dispersing their seeds before the plants are harvested. Seeds are projected on the ground by exploding capsules, and then secondarily dispersed by ants (Elias and McKey in press) and perhaps by other mechanisms. Although seed physiology is poorly documented, variable dormancy has been reported (N. Morante, Centre Internacional de Agricultura Tropical, Cali, Colombia, personal communication), and scattered anecdotal observations seem to show that preserving a vegetation cover prevents seed germination.

Seeds germinate whenever a new farm is cut in an old fallow. Spontaneous seedlings, ***tepuru pîye*** (from ***tepuru***, seed) are found in places that were cultivated as long as 35 years ago. One farmer even found a ***tepuru pîye*** plant in a farm he had just cleared in a high forest location three hours down river by canoe from Rewa, which was, according to oral tradition, last cultivated by a group of Caribs more than fifty years ago. He decided to multiply it, and called the new variety ***kari'na pîye***, "Carib stick." The surprisingly long dormancy suggested by this observation and by Amuesha comments (Salick et al. 1997) can be explained by the presence of seed banks along with seed propensity for long survival (Elias and McKey in press). Dormancy of seeds from a seed bank must be broken by cues. Many light-demanding tropical pioneer species respond to changes in light quality or soil temperature regimes following removal of vegetation. In others, germination is enhanced by the direct (high temperature) or indirect (higher concentration of minerals in ash) consequences of fire (Garwood 1989). Some of the cues that break dormancy of wild *Manihot* species and cassava seeds have been identified; they involve high temperature (Ellis et al. 1982; Nassar and Teixeira

1983) and scarification. As seedlings usually start growing before the first cuttings are planted, they do not suffer much competition from planted cassava. We have yet to gather information on the survival rate of seedlings. Up to 400 seedlings have been found in one young crop of 425 m_ (Elias and McKey in press), which is the highest density ever reported in the literature (Emperaire et al. 1998 report one or two seedlings per farm).

Farmers pay special attention to plants grown from spontaneous seedlings, which they have no difficulty identifying. Although they may compete with, and affect the growth of, planted cuttings, seedlings are only rarely weeded, and usually left to grow until they reach maturity. Like common varieties, they are harvested and their roots processed. If the farmer is satisfied with the yield, the color of the root, and any other characteristic, the stem is divided into cuttings which are soon replanted and multiplied in a specific location. If the tuberous roots are found unsatisfactory, the stem is generally discarded, although farmers keen to experiment clone it, hoping that it will become more productive after one cultivation cycle. ***Tepuru pîye*** are thus multiplied over generations of planting, and, since they often present novel combinations of morphological characters, are usually treated as new varieties. Naming these new phenotypes is not easy. Audacious farmers create appropriate names, such as, for example, Mr Nathaniel Edwards in Rewa, who, without hesitation, named a "very yellow" variety from a spontaneous seedling "I love stick" (***waakîri pîye***). Most farmers, however, take the view that all varieties are pre-existent, each with a fixed name, and so prefer not to invent new names. Consequently, they keep the nòn-specific denomination ***tepuru pîye***, which they apply to different phenotypes.

When the characteristics of a seedling closely match those of a known variety, the seedling, assumed to have grown from the seed of this particular variety, is assimilated to, and named after it (adding the term ***perurupe***, such as in ***paranakîrî pîye perurupe***, "seed of white man stick"). Seedlings which are considered entirely identical to a known variety are treated exactly like any other member of this variety. In the field, we were able to document four cases of such pseudo-reappearance of a known variety from a seedling. However, we suspect the frequency of complete assimilation of seedlings to known varieties to be much higher. Whereas it is easy to put one cutting aside in order to multiply a given variety, this is not the case when a great number of cuttings from the same variety have to be distinguished, hence the unconscious confusion and unintentional mixing of cuttings originating from seedlings with cuttings from pre-existing varieties. Farmers may not remember the seedling origin of particular stems, if the morphological characteristics of the latter are not sufficiently distinctive. Some of the farmers we interviewed were actually aware of making mistakes when identifying varieties, and of accidentally including new seedling phenotypes within known varieties. The assimilation of plants from seedlings into known varieties is one of the reasons for intravarietal genetic diversity in cassava grown by the Makushi (Elias et al in press), which is associated with intravarietal phenotypic diversity. Adding to the frequency of such confusion between similar varieties is the fact that the phenotypes of a given variety also vary with environmental factors.

Obtaining quantitative data on the incorporation of sexually produced indi-

viduals into the stock of material for vegetative propagation was extremely difficult. One farmer, a highly respected widow with a level of education above average, told us that in the high-forest farms cultivated by her husband and herself over a period of 15 years, cuttings from seedlings came to represent 30 per cent of the varieties grown, against 15 per cent for the varieties with which they planted the first farm in the area, and 55 per cent for the varieties they acquired through exchange with neighbours and relatives. We do not know whether this case is exceptional or representative. One would expect to find many varieties derived from seedlings in every farm, given the high density of seedlings growing in cassava farms, and the information volunteered by farmers, who say they multiply most of the ***tepuru pîye*** they find in their farms. However, when asked for the varieties previously multiplied from ***tepuru pîye***, farmers only name on average one or two (the maximum was eight). Such a contradiction can be explained by the aforementioned phenomenon of assimilation of ***tepuru pîye*** into other varieties. Another possible explanation is that these varieties, which are represented by a small number of individuals in the first generations, are easily lost. Besides, their identification requires a special memorisation effort on the part of farmers.

Seedlings are not only the sole source of novel genotypes; they are also, at times, the only source of cuttings. In 1950, as reported by many old people, farmers in the savanna experienced a very severe drought, which lasted almost two years. Their crops dried out, and they soon ran out of planting material, which they recovered by clearing old farm locations, where seeds germinated, providing them with new stocks of cuttings.

Local wisdom, according to which cuttings produce individuals similar to those from which they come (i.e. identical genotypes), is contradicted by the behaviour of ***tepuru pîye***, which rarely reproduce the characteristic features of the particular varieties from which the seeds originate, but display instead novel or unusual combinations of traits, due to recombination in a genome that is very heterozygous (Colombo 1997; Lefèvre 1989), a property enhanced by allogamous reproduction (Rogers 1965). Makushi farmers, who find the unusual trait combinations of seedlings quite puzzling, explain them by presuming that a seed from a given variety, because of its small dimensions, is influenced by other varieties after falling to the ground, and denatured.

This perception may in turn explain why they never plant cassava seeds, but propagate clones of ***tepuru pîye***, despite their knowledge of seed planting, a technique commonly used to grow crops such as papaya and corn. It may also explain why farmers never give away cuttings from spontaneous seedlings, but only cuttings from third or fourth generation clones, which they have replanted in various types of soil, and observed. In any case, cuttings from ***tepuru pîye*** are greatly appreciated for their "vitality," their "youth." As one farmer told us, normal cuttings (i.e. clones) get too "accustomed to the soil," they are too "tamed," and end up producing less and less, while cuttings from spontaneous seedlings often produce increasingly better yields (see Rival [in press] for further discussion of cultural representations associated with ***tepuru pîye***).

DISCUSSION

Makushi cassava diversity in the Amazon context.–Bitter cassava is the staple crop of most lowland Amazonian Amerindians, and the Makushi, who possess at least 76 varieties, are no exception. This high varietal diversity is comparable to the diversity encountered in other groups. Grenand (1993) counted 31 bitter varieties in a Wayãpi community in French Guiana, and Carneiro (1983) 46 among the Kuikuru of Brazil; Emperaire et al. (1998) found 61 bitter varieties in one caboclo village, and a total of 140 names among all the villages they studied; Dufour and Wilson (1996) found more than 100 varieties among Tukanoans from Yapu in Colombia, and Chernela (1987) collected 137 different names among four communities along the Uaupés river in Colombia. A comparable level of diversity is encountered among sweet cassava farmers: 117 names were collected by Salick et al. (1997) in 16 Amuesha communities, and more than 100 by Boster (1984b) among the Aguaruna in Peru.

Genetic implications of traditional management.–Despite its peculiarities, the Makushi farming system, which shares many features with other native Amazonian cassava farming systems (slash-and-burn agriculture, strong environmental pressure, conservative human selection, planting system, incorporation of seedlings, and so forth), can be used as a model to study the genetic consequences of traditional management.

Cassava, which grows in an ecosystem shaped by both environmental and cultural factors, is the target of two interacting types of selection, natural and human. Human selection is either conscious or unconscious. Genotypes constitute ultimately the units of selection in both natural and unconscious human selection. In the case of deliberate human selection, however, the units of selection are the taxonomic units. One taxonomic unit can include several genotypes, given the assimilation into a single variety of different clones with similar phenotypes and of plants of sexual origin. If a farmer decides to multiply such a heterogeneous variety, she or he may multiply not only one genotype, but several, while, at the same time, taking the risk of losing other genotypes, because (1) genotypes sharing the same phenotypes are indistinguishable, and (2) no special effort is made to maintain all the intravarietal phenotypic variation (Boster 1985).

Although human and natural selection have distinct origins, they nevertheless act as similar agents of evolution (Salick 1995), and may even interact. Human deliberate selection on features such as productivity can be superimposed on, and reinforce, natural selection. In a given environmental context, selection for productivity can constitute selection for resistance to drought, herbivory, or other ecological factors (Johns 1990; McKey and Beckerman 1993). To understand the observed patterns of varietal diversity, therefore, both natural and artificial selection must be taken into consideration.

What are the consequences of natural and human selection, and of their interaction, on genetic diversity? Pressures may either increase or decrease varietal diversity. At the farm and community level (intervarietal diversity), environmental pressures may lead to local or short-term decreases in varietal diversity. Varieties

can be lost, for example, during a flood or after ant attacks. Human selection may also lead to decreased diversity, when a variety is accidentally lost because of lack of suitable space to plant it, or when it is deliberately discarded. Since criteria for discarding a variety are mainly based on productivity, human selection acts, in this case, in the same direction as natural selection.

Human selection can also increase varietal diversity. Makushi farmers tend to favour new varieties that are more liable to disappear, for they are represented by a few individuals only. Since the environment is highly variable and unpredictable, natural selection will not always favour the same genotypes. Makushi appreciation of diversity for its own sake leads them to keep many varieties, even if they are not currently very productive. Although this is not an explicit, deliberate strategy, the result is possession of a varietal pool globally resistant to many kinds of pressures.

Unlike most tuber crops, cassava is propagated by stem cuttings, a material different from the edible part. The absence of use competition between material for propagation and for food enables farmers to be more selective about what is planted. With exchanges of planting material occurring widely among villagers, a variety accidentally lost in a farm is easily recovered, and the risk of losing varieties greatly diminished within the community. Such exchanges also allow farmers to acquire new varieties and increase their own varietal diversity. Furthermore, exchanges taking place between different communities lead to increased diversity at the village level. Intervarietal diversity is further increased with the multiplication of volunteer plants grown from seedlings, ***tepuru pîye***, which create new genotypes. Aside from somatic mutations, probably of rare occurrence, ***tepuru pîye*** are the only source of original diversity.

Compared to many other Amazonian groups, the social context of Makushi farming is favourable to a high degree of varietal diversity. Firstly, in the Makushi farming system, each household manages varietal diversity on its own farms. In contrast, the Amuesha (Salick et al. 1997) delegate the management of diversity to their shamans, who not only must grow many more varieties than other farmers, but who are also responsible for experimenting with the plants grown from seedlings. Such a centralised system based on a reduced number of specialists may have the advantage of ensuring a more homogeneous redistribution of diversity, but it is far more vulnerable. Secondly, and although they are said to be acculturated, having been converted to Christianity (but see Butt-Colson's [1967] work on Pemong and Akawaio millenarist movements) and having lost many of their customs and traditions, the Makushi have preserved a strong sense of collective identity and have maintained their traditional subsistence agriculture. Makushi choices on whether or not to plant a given variety, and on the frequency of planting each variety, are still personal choices which are not yet dictated by the market economy or any other external factors. Their situation differs from that of detribalised and socially destabilised Tukanoans described by Grenand (1993), who have lost their knowledge of cassava cultivation and processing, a loss that has led to a dramatic impoverishment of cassava diversity in Tukano land. Thirdly, Rewa and other Makushi forest villages are not subjected to market forces. Various authors (Salick et al. 1997; Emperaire et al. 1998) have shown that markets

push farmers to increase productivity and to cultivate a restricted range of commercial varieties, furthering the tendency to grow highly productive varieties at the expense of rarer varieties that may, as a result, get lost.

We have presented the ways in which intervarietal genetic diversity is shaped by environmental and human pressures. But what are the genetic consequences at the intravarietal level? Scientists studying cassava genetic diversity commonly assume that varieties are clonal, because they are propagated vegetatively. However, the incorporation of sexually produced cassava in a variety, and more generally, the confusion between two types of cassava that have similar phenotypes, lead to intravarietal genetic diversity (Colombo 1997, Elias et al. in press). Intravarietal diversity is observed despite the fact that each variety is subject to a phase of intense genetic bottleneck, when cuttings are selected for the next generation. Since an adult plant can provide from two to fifteen cuttings, a farmer often has too many cuttings to plant, except when he or she is planting a new farm. Surplus cuttings may be given to neighbours or relatives who need them, but the bulk is simply planted in large bundles at the edge of the farm. These cuttings are functionally 'dead,' since they will either die out, or grow without being replanted. In other words, only a small proportion of individuals in each variety participates in producing future generations. Some genotypes may be eliminated in this way through genetic drift, leading to a decrease of intravarietal genetic diversity at the farm level. Observed intravarietal diversity (Elias et al. in press) is thus the result of the balance between the frequency of confusion of plants sharing similar morphological characters, and the strength of genetic bottlenecks.

CONCLUSION

The results presented here illustrate the ways in which selective pressure is exercised by various socio-cultural factors. This study should be regarded as a first step in the proposed integrative approach, which will be used as a background for understanding forthcoming results of genetic analyses and ecological experiments.

NOTES

[1] The putative wild relative of cultivated cassava *Manihot esculenta* subsp. *flabellifolia* (Olsen and Schaal 1999) is not found around Rewa, but small populations exist around other villages in the savannah area (at least 75 km away from Rewa). Wild cassava (***kwana***) cuttings are not planted, nor are the tuberous roots used, although old people in the savanna report having eaten mixtures of wild cassava and cultivated cassava roots during times of starvation in the 1950s. Genetic data (Elias et al., in press) suggest that gene flow from wild cassava is not a significant evolutionary factor in cultivated populations in Guyana, and that the local wild gene pool has contributed little to the diversity of the cultivated pool.

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Utilización y conservación de los ecosistemas terrestres de México, pasado, presente y futuro. Antony Challenger with the collaboration of Javier Caballero. Comisión para el Conocimiento y Uso de la Biodiversidad; Instituto de Biologia, Universidad Nacional Autónoma de México; Agrupación Sierra Madre, S.C. 1998. 847 pp., maps, diags., photos, refs., and index. Paper. ISBN 970-9000-02-0.

In the preface of this book Antony Challenger explains how he set out to write this enormous tome. As he describes it, only someone young (he was 26), enthusiastic, and inexperienced would have accepted the challenge to write a single book that was both sufficiently detailed and broad enough in scope to serve as a basic text on conservation in Mexico. It took him seven years and 847 pages. The result is an extensive and invaluable overview of the political and cultural ecology of biodiversity in Mexico.

The book consists of an introduction, a four-chapter section on the history of human uses of ecosystems, six chapters covering the biogeography, ecology, and human uses of the main terrestrial ecosystem types, and a conclusion addressing sustainable development in Mexico.

In the introductory chapter, Challenger explains the importance of biodiversity, summarizes the threats to biodiversity in Mexico, and describes how indigenous and traditional farmers continue to make important contributions to Mexican biodiversity through ongoing processes of domestication and adaptation of existing crop varieties to differing ecosystems and human needs. Specific topics include species relationships, co-evolution, natural selection and the major activities threatening biodiversity in Mexico. In contrast to the destruction of Mexican ecosystems under modern production techniques, indigenous agricultural activities enhance biodiversity through ongoing processes of domestication and diversified production systems maintaining a heterogenous landscape.

Chapter Two covers "primary production and the conservation of natural resources" from the Pleistocene to the Spanish Conquest, including the origins of agriculture in Mexico, and the agricultural basis of several pre-Columbian civilizations in Mexico. Chapters 3, 4 and 5 address the Colonial period, independence, the Porfirian dictatorship, and modern Mexico from 1910 to 1994. Each of these chapters concludes with a map of Mexico illustrating the general distribution of agricultural, grazing, forestry, mining, and industrial activities and the ever-growing extent of alterations to natural ecosytems.

These chapters take a cultural ecology perspective in which society and nature are interwoven. For example, the culture of the Maya encompasses their agricultural systems and settlement patterns, and these have repercussions on vegetation and wildlife. In the same way, environmental change affects society and a number of theories for the collapse of Mesoamerican cultures hinge on environmental change. In his discussion of the conquest, Challenger describes a process of cultural *and* ecological transformation in Mexico following the introduction of new species, including human pathogens like small pox and scarlet fever. In the chapter covering modern Mexican history, Challenger addresses the environmental implications of topics such as land reforms, import substitution industrialization,

tropical colonization and the promotion of cattle ranching, agricultural policies, the debt crisis, and finally neoliberalism.

Historically and currently, Mexican development strategies are unsustainable. Furthermore, they are actively destroying the bases from which Mexico could construct a sustainable development alternative. One of the greatest tragedies of the Spanish Conquest and colonization, for example, was the loss of indigenous technical knowledge, agricultural techniques, and perhaps crop varieties. These disappeared with the drastic re-organization of production around European plants and animals, mining, and export crops like dyes and sugar, and the collapse of indigenous populations. Currently, the North American Free Trade Agreement continues the process by pitting Mexico's small-scale indigenous maize farmers against enormous and heavily subsidized agro-industries in the United States and Canada.

After setting out the human history of land use in the first 250 pages of the book, Challenger is ready to describe the current situation of primary production and conservation and vegetation types. Chapters 6 through 11 focus on specific ecological zones. Topics include the sources of various taxa, profile drawings of different forest types, and descriptions of the main ecological processes shaping these ecosystems, such as forest succession. Challenger provides long lists of current and suggested protected areas in each of the five major ecosystems. Most importantly, each chapter describes indigenous and modern systems of management in each ecosystem type.

The final chapter reiterates the value of indigenous technical knowledge and traditional environmental management systems. In contrast to green revolution agricultural techniques that homogenize the environment, rely on unsustainable chemical and fossil fuel energy inputs, deplete soil and water, poison people and face real risk of collapse, traditional agricultural systems maintain environmental heterogeneity and often have proven sustainability. Ethnoecology, therefore, has an important role to play in the search for sustainable environmental management.

Challenger argues that sustainable development in Mexico requires the conservation and intensification of traditional farming systems, including serious efforts to rehabilitate soils and forests. This, in turn, requires a radically different development strategy, one based on food self-sufficiency, not the current "market logic" of importing grains. Sustainable development requires a paradigm shift, *a la* Kuhn. A drastic change in thinking should accompany a global redefinition of development leading to semi-autonomous national economies trading as equal partners. In Mexico, sustainable development would also require land reform, especially directed against cattle ranches in tropical zones.

In his final paragraph, Challenger writes that the biggest challenge is not how to manage natural resources, but rather how to manage ourselves. This is the weakest aspect of the book. The power relations behind the market structures and government policies he criticizes remain opaque. In a brief section on plantation subsidies, for example, Challenger does not address the issue of how these subsidies disproportionately benefit transnational integrated pulp and paper companies and fail to reach the small-farmer actors he expects to use them to restore de-

graded environments. Similarly, he is very optimistic about the ability of biotechnology to play a role in improved traditional systems, without considering the goals of the actors behind most biotechnology research.

In another example of the book's relative weakness on social issues, Challenger calls for the establishment of more parks and the funds to delineate and patrol them as part of a broader process of ecological zoning and land use planning. The United States park system remains a model suitable for emulation (p. 785). He does not address the state of conservation within existing Mexican parks, nor the compelling and difficult issues of social justice, cross boundary, and other people management issues in Mexico's parks, many of which are inhabited and nearly all of which are heavily used.

Conversely, though, the description of Mexico's ecosystems, their natural histories, human impacts, and indigenous production strategies comprise the strength of the book. Challenger demonstrates the value of ethnoecology for sustainable development, clarifies the cultural and ecological destructiveness of past and present development policies, and identifies potential techniques for better management.

Unfortunately, the book's size and organization dilute these compelling messages. The book would have benefited from better editing. The conclusion, for example, contains sections on human impacts on ecosystems and potential areas for parks that should have been included in the respective ecosystem chapters where there is similar material. The conclusion also contains lengthy discussions of ecotechniques like agroforestry, organic agriculture, and organic coffee, but these too should have been contained in the ecosystem chapters with similar material. Similarly, a few tables could have replaced pages of description of protected areas throughout.

Even with such editing, the book should be printed in two or more volumes. Incredibly, this 850-page book is published in a single paperback volume. This is a book that needs to be in every Mexican college library and accessible to every organization addressing conservation and development issues in Mexico. Unfortunately, even moderately-used copies will rapidly fall apart; my copy already has a cracked spine. It is too bad the book is not itself more sustainable.

Despite the length, a thorough index and a detailed table of contents make the material accessible. Challenger maintains an author-date citation style throughout with references following each chapter, and this guarantees the utility of the book as an obligatory desk reference for all Latin Americanists with interests in the intersections between biodiversity, people, politics, and history. We are fortunate Challenger took on a Herculean task, and executed it so well.

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HISTORICAL ECOLOGY OF THE SOUTHEASTERN LONGLEAF AND SLASH PINE FLATWOODS: A SOUTHWEST FLORIDA PERSPECTIVE

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ABSTRACT.—Before EuroAmerican settlement of the southeastern U.S., longleaf pine (*Pinus palustris* Mill.) was present and largely dominant on an estimated 85 percent of all upland area within the longleaf's botanical range. Today, longleaf is present on only about 2.6 percent of those uplands. In addition, uplands forested with slash pine (*Pinus elliottii* Engelm.) have been reduced from a pre-EuroAmerican 3.3 percent to just 0.4 percent (Frost 1993). This dramatic landscape change is a result of long-term relations between the pine ecosystems and human activity. Understory plants, soil moisture, and periodic fire were ecological factors while domestic animals, agriculture, the naval-stores and lumber industries, and fire reduction were human-related factors. Some of the Southeast's last old-growth pine forests were logged in south Florida during the 1920s, 1930s, 1940s, and 1950s. Mostly of the pine flatwoods type, these were the southernmost forests in the longleaf pine's range and they included both longleafs and the south Florida variety of slash pine (*Pinus elliotti* var. *densa* Little & Dorman). In southwest Florida's Lee County, historic and oral-historic research focused on the pine flatwoods near Fort Myers, north and south of the Caloosahatchee River. South of the river, an archaeological survey documented the remains of a major component of the 1924-1944 logging operation that greatly impacted the flatwoods of both areas. The results of this historical ecology research illustrate the heterogeneous process of landscape change at regional (Southeast U.S.), subregional (south Florida), and local (southwest Florida) scales.

Key words: historical ecology, longleaf and south Florida slash pines, southwest Florida, oral history, archaeology.

RESUMEN.—En el sudeste de los Estados Unidos, y antes de la colonización de los euro-americanos, la presencia de los pinos de hoja larga (*Pinus palustris* Mill) dominaban en gran parte el terreno elevado que quedaba dentro del área demarcada botánicamente para este tipo de pino. Se estimaba que el área compendia un ochenta y cinco (85) por ciento del terreno. Hoy día, tan solo el dos punto seis (2.6) por ciento de los pinos de hoja larga están representados dentro del terreno demarcado botánicamente. Además, las areas en los bosques de terrenos más altos donde se encuentran los pinos cortados (*Pinus elliottii* Englem) han sido reducidas a cero punto cuatro (0.4) por ciento, en comparación a el tres punto tres (3.3) por ciento que existía durante la época pre euro-americana (Frost 1993). Este cambio tan dramático en el paisaje es el resultado de las relaciones que han existido durante mucho tiempo entre el sistema ecológico de los pinos y la actividad humana. Esto es nos indica que las plantas, la humedad en terreno, y los incendios

que occurieron periódicamente, fueron los factores ecológicos. Los factores humanos que contribuyeron a éste cambio fueron, los animals domésticos, la agricultura, las tiendas de tipo marino o náutico, las industrias de madera, y la reducción de los incendios. En el sudeste se encuentra el crecimiento de algunos de los bosques de pino más viejos y que fueran registrados en el sur de la Florida durante los años 1920, 1930, 1940, y 1950. En su mayoría, los pinos del tipo se encuentra en las areas de terrenos llanos están en la parte sur de Florida y son de hoja larga, así como la variedad de pino cortado (*Pinus elliotti* var. *densa* Little & Dorman). En el Condado de Lee, que se encuentra en el sudoeste de la Florida, hay estudios históricos y de historia oral donde se enfoca el tema de los pinos en las llanuras cerca de Fort Myers y en la parte norte y sur del Río Caloosahatchee. En un estudio arqueológico que se realizó al sur del río, se hizo possible el documentar los restos de uno de los componentes principales en la operación de la extracción de madera durante los años de 1924 a 1944 y lo que causó un gran impacto en los bosques que se encontraban en los terrenos llanos de ambas áreas. En una inspección de tipo histórico-ecológico se pudo documentar el processo etereogéneo donde se demuestra en gran escala la grandesa en el cambio del paisaje de la región (sudeste de los Estados Unidos), la sub-región (sur de la Florida), y la parte local (al suroeste de la Florida).

RÉSUMÉ.—Avant l'implantation euro-américaine dans le sud-est des Etats-Unis, le pin des marais (*Pinus palustris* Mill.) était courant et prédominait largement avec une estimation de 85 pour cent de tout le haut pays classé dans la variété botanique du pin des marais. Aujourd'hui, le pin des marais se trouve seulement dans 2,6 pour cent du haut pays. De plus, les hautes terres boisées de pitchpins américains (*Pinus elliottii* Engelm.) ont été réduites d'un pourcentage preéuro-américain de 3,3 pour cent à seulement 0,4 pour cent (Gel de 1993). Ce changement dramatique de paysage est le résultat de relations à longs termes entre les écosystèmes du pin et l'activité humaine. Les plantes des sous-bois, l'humidité du sol et les feux périodiques furent les composants des facteurs écologiques alors que les animaux domestiques, l'agriculture, l'équipement naval et les industries du bois, la réduction de feu, furent les facteurs relatifs à l'homme. Certaines des dernières anciennes forêts de pins du sud-est furent abattues dans le sud de la Floride dans les années 1920, 1930, 1940 et 1950. Principalement forêts de pins, on les trouvait le plus au sud sous la variété de pins des marais et elles comprenaient à la fois les pins des marais et la variété de pitchpins américains (*Pinus elliotti* var. *densa* Little & Dorman) de Floride du sud. Dans le County Lee de Floride du sud-ouest, la recherché historique et orale historique s'est focalisée sur les forêts de pins près de Fort Myers, au nord et au sud de la rivière Caloosahatchee. Au sud de la rivière, un étude archéologique a révélé les restes d'un élément majeur de l'opération de 1924-1944 sur l'exploitation du bois qui a grandement influencé les forêts de chacune des régions. Les résultants de cette recherche écologique historique illustre le processus hétérogène de changement de paysage à l'échelle régionale (le sud-est des Etats-Unis), sous-régionale (le sud de la Floride) et locale (le sud-ouest de la Floride).

INTRODUCTION

Historical ecology, as defined by Crumley (1994a, 1994b, 1998) and others (Balée 1998; Headland 1997; Winterhalder 1994), is the multidisciplinary, multiscalar study

of the dialectical relations between people and the physical environment. This approach views the cause of cultural and ecosystem change as interactive rather than deterministic. Crumley (1994b:6-7) states that "long-term sequences may be traced through the study of changing landscapes, defined as the material manifestation of the relation between humans and the environment." Examination of landscape change at more than one temporal and spatial scale is crucial to the analysis because the process of change at one scale may not be the same at another scale (Marquardt and Crumley 1987:2-9). Combinations of archaeology, ethnohistory, ethnography, ethnoecology, ethnobiology, history, geography, and the environmental sciences are appropriate to the integrative study called for by a historical ecology approach. Ethnobiology, for example, focuses on the relations between people and plants and animals but does not emphasize the historical (including archaeological) continuum or landscape elements other than plants and animals. Historical ecology is broad in scope, potentially encompassing the multiscalar past and present, and multiscalar landscape elements such as climate, fire, geomorphology, soils, plants, animals, and humans.

Employing the approach of historical ecology, I examine a landscape change that occurred across the Coastal Plain region of the U.S. Southeast—the greatly diminished forest ecosystems of the longleaf pine *(Pinus palustris* Mill.) and the slash pine *(Pinus elliottii* Engelm.) (Little 1971; Wunderlin 1998)—but with a local-scale focus on the pine flatwoods of southwest Florida's Lee County. Longleaf pines were once so abundant in the Atlantic and Gulf Coastal Plain states that they and their plant and animal associates composed one of the dominant forest ecosystems of the region (Frost 1993; Wahlenberg 1946; Walker 1991). Old-growth longleaf and slash pine forests greeted early European and EuroAmerican explorers, travelers, and settlers to the Southeast; these once-seemingly endless forests were described as open stands of pines towering over a low understory often dominated by grasses or saw palmetto (*Serenoa repens* W. Bartram). Deforestation of the region's old-growth pine forests was a long process encompassing several hundreds of years but intensifying primarily during the eighteenth through twentieth centuries. Frost (1993) presents an excellent synthetic environmental history of the longleaf at this long-term regional scale.

Examining the longleaf pine from a south Florida perspective is also important because this subregion supported the southernmost forests of longleaf and their penetration into Florida's subtropics is not well documented or understood. Longleaf pine forests in south Florida were and are of the flatwoods type, the land generally being too low to support the sand-hills longleaf forest type. In addition, the subregion's slash pine is *Pinus elliottIi* var. *densa* (Little & Dorman), distinct from the typical northern variety, *Pinus elliottii* var. *elliottii;* the former has some characteristics similar to longleaf (Abrahamson and Hartnett 1990:112; Moyroud 1996-1997:11; Small 1930; Snyder et al. 1990). Earlier in the twentieth century, the south Florida slash pine was thought to be *Pinus caribaea* Morelet, the Caribbean pine (e.g., Harshberger 1914; Small 1930:42). Indeed, the southernmost slash pinelands (e.g., Everglades National Park) exhibit a distinct assemblage of plant taxa owing to their subtropical location (Snyder et al. 1990). The distributions of longleaf and south Florida slash pines overlap at least in the northernmost areas of south Florida (e.g.,

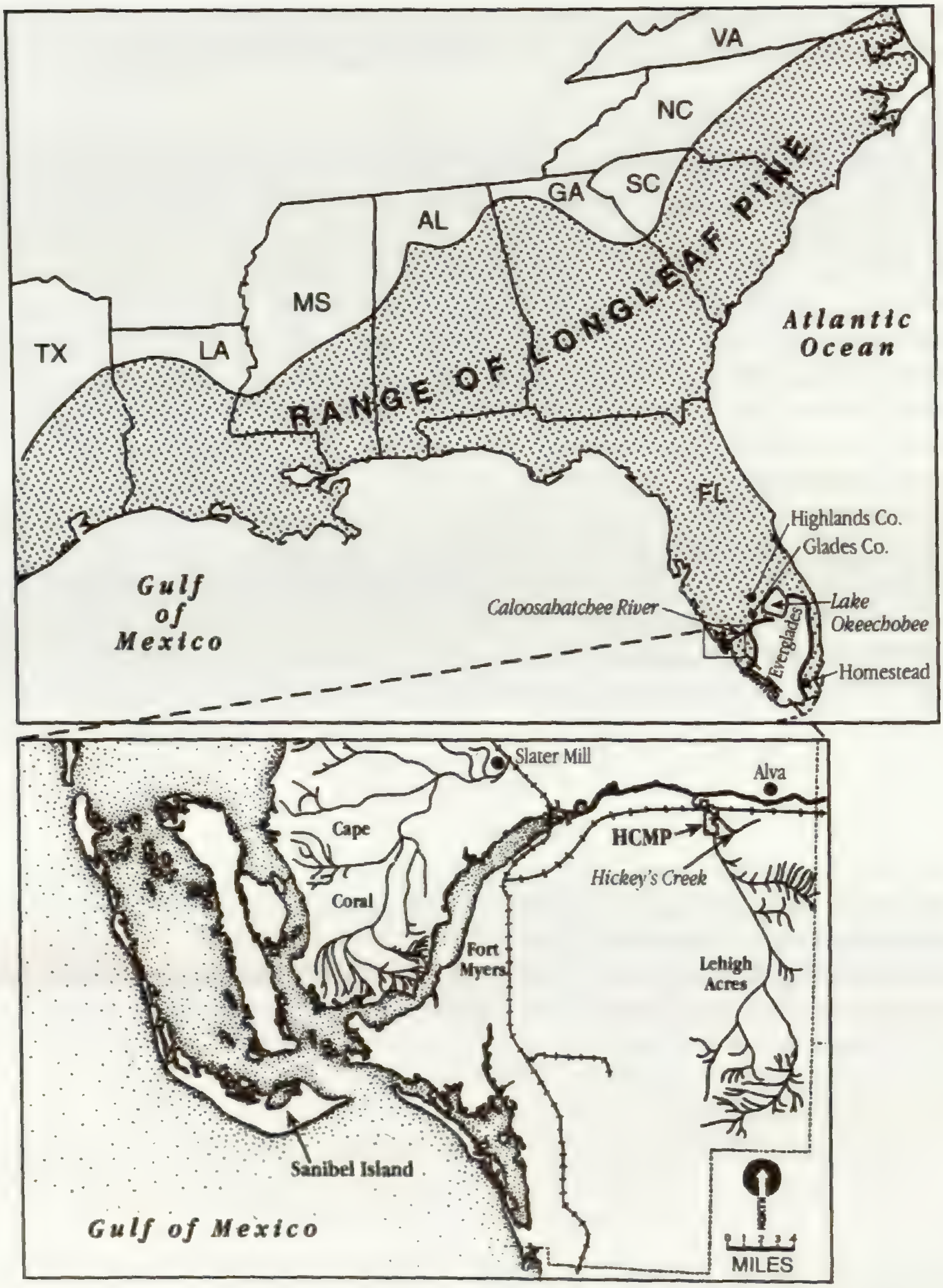

FIGURE 1.—Map showing estimated pre-EuroAmerican Southeast U.S. range of longleaf pine *(Pinus palustris* Mill.) and botanical ranges of typical slash pine *(Pinus elliottii elliottii* Engelm.) and south Florida slash pine (*Pinus elliottii densa* Little and Dorman). The longleaf range is generally based on Frost's reconstruction synthesizing numerous sources (1993:Figure 2). The more detailed southwest Florida range is based on Harshberger (1914) and Sudworth (1913:Map 35). The slash pine ranges are from Little (1971, 1977). Inset map is of Lee County showing the Hickey Creek Mitigation Park (HCMP) and the Cape Coral and Hickey's Creek/Lehigh components of the McWilliams/Dowling & Camp logging system (as reconstructed by James Pickens from 1944 aerial photographs), Slater Mill, and other locations mentioned in the text. The shaded areas are hypothesized to have been forested with a mix of old-growth south Florida slash pines and longleaf pines.

Lee County, Highlands County). A third native pine, the sand pine (*Pinus clausa* Chapm.), is found in the western half of Lee County with its southernmost occurrence in extreme western Collier County (Harshberger 1914:Map; Little 1978:Map 4). South Florida was one of the last areas of the Southeast to experience intensive EuroAmerican settlement. Thus, the subregion's pine forests were some of the last of the Southeast's old-growth pine forests to be logged. Clear-cut logging, the final phase in the Southeast's pine-deforestation process, did not begin in southwest Florida until the 1920s (Zeiss 1983), continuing to as late as 1956 (Tebeau 1957). Thus, a few individuals with first-hand knowledge of south Florida's old-growth forests and their destruction are still living today, representing valuable oral-historic resources. And logging-related features and archaeological deposits are still evident on the landscape, allowing documentation.

THE PRE-EUROAMERICAN PINE FORESTS

A Problematic Documentation.—Researching historical documents concerning the southern pines is problematic (Frost 1993:18; Wahlenberg 1946:268). This is largely due to the botanical similarity of the four yellow pines—longleaf, slash (two varieties), shortleaf (*Pinus echinata* Mill.), and loblolly (*Pinus taeda* L.) (Wunderlin 1998:62)—and their often overlapping distributions (Little 1978:Maps 5, 6, 8, and 10). Of these four pines, however, only the south Florida slash and longleaf pines are native in south Florida. Even so, whether referring to south Florida or areas to the north, early land surveys, maps, and travelers' accounts seldom specify the species of pine recorded.

A plethora of common names have been used at any one time for these pines, all described as "yellow" because of their wood color (Record and Hess 1943). Wahlenberg (1946:268) explains that patterns of geography and sometimes economics (i.e., pine products) could be observed in the variation of names. For example, longleaf pine was generally called "fat" pine in the deep south, "longleaved" and "longstraw" pine in the Atlantic states, "turpentine" and "rosemary" pine in North Carolina, "brown" pine in Tennessee, and "orchard" pine in Texas. Loggers and lumbermen variously called longleaf "yellow" pine, "heart" pine, "southern" pine, "hard" pine, and "pitch" pine (see also Mohr 1896:28; Panshin and deZeeuw 1980; Record and Hess 1943). Mohr (1896:28) lists "slash pine," "swamp pine," "bastard pine," "meadow pine," and "she pine" as common names used for slash pine.

Most bothersome to researchers, the word "longleaf" was sometimes used in the lumber industry to indicate any of the yellow pines that met lumber standards of high quality. To Wahlenberg (1946:268), this confusion was understandable from a lumberman's point of view because the yellow pines that are easily distinguished morphologically cannot always be distinguished (anatomically) by their wood (see also Record and Hess [1943] and Panshin and deZeeuw [1980] for examples of gymnosperm keys that reflect this problem). In addition, early forestry surveys often combined longleaf and slash pines in a category called "turpentine pines" when reporting acreages (Wahlenberg 1946:xiii-xiv, 1), in part due to intergrading (i.e., mixed stands) of the two species.

Archaeological and paleoecological documentation of the pines is equally as problematic, if not more so, as historical and ethnobotanical documentation. The most frequently recovered archaeological plant remains are in the form of small fragments of charred wood, often found in great quantities. Although charred wood fragments often can be identified to species under microscopic examination, wood anatomists and archaeobotanists are not able to distinguish between the southern species of *Pinus* (Panshin and deZeeuw 1980; Record and Hess 1943). Unfortunately, this inability also applies to preserved, waterlogged wooden artifacts. Paleoecologic study of pine pollen is also limited to the genus level, as pollen from the various species are "difficult or impossible" to distinguish (Watts 1993:15). However, one promising, indirect, avenue of identifying past longleaf woodlands is the determination of the mass and relative abundances of associated understory plants based on phytoliths recovered from soils (Kalisz et al. 1986:187).

Estimates of Acreage and Range.—Despite the difficulties of historical research, reconstructions of acreage and range have been approximated for pre-EuroAmerican times, especially for longleaf pine. Reported estimates for the acreage of southeastern longleaf forests range from 50 to 92 million (e.g., Frost 1993; Landers et al. 1995; Wahlenberg 1946:8; Walker 1991:128). For example, Frost (1993) calculates that 92 million acres of the region's woodlands included "some longleaf pine" and of that acreage perhaps roughly 74 million acres were longleaf-dominated woodlands. One writer reports that only .002 percent of the old-growth forests remains (Winn 1996:15). Estimates for current acreages range from 1 to 5 million (e.g., FCMP 1995; Landers et al. 1995; Longleaf Alliance n.d.). A 1995 systematic inventory by county of longleaf pine (comprising more than 50 percent of the tree cover) resulted in an estimate of 2.95 million acres (Outcalt and Sheffield 1996:2). Of the current longleaf acreage, Virginia has none and Florida has the most, almost one million acres (Outcalt and Sheffield 1996:20).

Estimates of longleaf's pre-EuroAmerican areal distribution also vary. Wahlenberg (1946:46) distinguishes between a botanical range (potential range) and a commercial range (range of exploitable forests), pointing out that most reconstructed distributions were probably based on commercial (i.e., exploitable) ranges, resulting in conservative boundaries (e.g., Mohr 1896; Sargent 1884). Thus, he concludes that the pre-EuroAmerican longleaf-forest boundaries lay somewhere between the two ranges. Frost's (1993:18) recent reconstruction of longleaf's range may be the best to date at the regional scale because it is a synthesis of the major studies published between 1861 and 1971. But it does not depict the true nature of longleaf's southernmost distribution. Wahlenberg (1946:49-50) notes that longleaf is restricted in its northern distribution by snow, which is dangerously heavy when accumulated on the tree's long needles. However, competition from deciduous species may be a more important factor. Generally, longleaf pine extended across the Coastal Plain (Figure 1), from southeastern Virginia across to portions of Louisiana and a small area of eastern Texas (Frost 1993). Distribution maps also consistently show that longleaf pine was found throughout Florida's panhandle, and its north and central peninsular regions. Typical slash pine had a more restricted, even more southern range, generally distributed from southern South Carolina to central Florida and west to southeast Louisiana (Little 1971; Figure 1), often characterized as concentrating along the coastal areas (e.g., Sargent 1884:520).

The southern longleaf boundary may be the more difficult of the two to reconstruct because the distribution of the south Florida slash pine overlaps with the southernmost longleafs (Figure 1) and the similarity of the two yellow pines has resulted in an often ambiguous historical record. Apparently, it is increased soil moisture that marks the longleaf's southernmost extent (Abrahamson and Hartnett 1990:111-112; Peet and Allard 1993:61). Like typical slash pine, south Florida slash pine is more tolerant of poorly-drained soils and as a result is the more dominant pine across south Florida. The majority of pre- and post-EuroAmerican maps depict longleaf's range as halting northwest of Lake Okeechobee in south-central Florida and at the Caloosahatchee River in southwest Florida, limited to the mainland (e.g., Frost 1993:18; Little 1978:Map 8; Schwarz 1907; Wahlenberg 1946:44). It may be that these south Florida boundaries were "commercially drawn," as Wahlenberg called it, and therefore are conservative. (This is certainly the case with the forest-survey maps of Mohr [1896] and Sargent [1884].)

For example, University of Florida herbarium records document scattered longleafs in the Estero area (FLAS 120603, collected 1975) of southwestern Lee County and an "extensive open stand of [longleaf] trees" on Pine Island (FLAS 82831, collected 1961), west of mainland Lee County (Figure 1 inset). Outcalt and Sheffield's (1996:19) inventory shows acreages of longleaf-dominated forest in two south Florida counties, Glades and Highlands, west and northwest of Lake Okeechobee (Figure 1). Frost's (1993:18) reconstruction includes this Okeechobee locale, depicting it as part of a division called "scattered longleaf pine in slash pine areas transitional to south Florida communities."

Importantly, botanist John Harshberger (1914:89) traveled through Lee County (including what is today Collier County) early in the last century and reported that "on the west coast, south and north of the Caloosahatchee River, the slash-pine mingles with the long-leaf pine, *Pinus palustris* Mill." and in another entry, "scattered growths of longleaf-pines, *Pinus palustris* Mill., continue south of the Caloosahatchee River into Lee County on the authority of J. A. Davison, an engineer, as far as Surveyor's Creek, and the tree has been reported at Henderson's Creek, but it is not an important element of the forest, which consists of the slash-pine, *Pinus caribaea* Morelet [today known as *Pinus elliottii* var. *densa*] and associated species." Surveyor's Creek, today known as the Imperial River (Grismer 1982:330), is located in southernmost Lee County (Figure 1 inset). Henderson's Creek is located even farther south, between Naples and Marco Island, in today's Collier County. Sudworth's (1913:Map No. 35) botanical range for longleaf pine includes most of Cape Coral. It also extends south of the Caloosahatchee River including a locale overlapping eastern Lee County and western Hendry County, a band along the river, Pine Island, and a locale in the Estero area of southern Lee County. Based on Harshberger and Sudworth, Frost's presettlement transitional mixed longleaf-slash zone should be extended to include parts of southern Lee County in order to depict more accurately longleaf's southernmost botanical range, as I have indicated in Figure 1.

Longleaf and Slash Pine Forest Ecosystems.—Eighteenth and nineteenth-century accounts of travels through the Southeast paint images of extensive open forests of tall pines (e.g., Bartram 1791:43, 186, 191; Brinton 1869:95, 104; Romans 1775:14-

17; Vignoles 1823:86-87). One could see for a great distance into the forests. It was thus also easy to travel through them and to hunt game animals, described as abundant. In some cases, longleaf was clearly the dominant tree being described (e.g., Bartram 1791:33, 52; Romans 1775:16) but more commonly, only the generic "pines," "pinelands," "pine flatwoods," etc. were indicated. Similarly, Harshberger (1914:90) and Small (1930) described the south Florida slash pine forests as "unusually open" with an unobstructed view, and "endless." These early accounts and others suggest that pre-EuroAmerican slash- and especially longleaf-dominated forest ecosystems may have been characterized by a lower understory than most pine forests of today. The interpretation is far from certain (Myers 1990:182), however, because by the eighteenth century, feral and free-ranging European-introduced hogs and cattle were abundant in the pine forestlands, grazing and foraging in the understory (e.g., Romans 1775:16).

General characteristics of mature longleaf-dominated pine ecosystems include: low longleaf stand density; minor hardwood component, mostly oaks; grass-dominated groundlayer; high plant species richness; frequent surface fire; occurrence across a wide geomorphic and hydrologic gradient (although well-drained sandy soils are most common); and stands of uneven-aged trees (Landers et al. 1995:40; Palik 1995:6; Schwarz 1907:3-17). An important difference between longleaf and slash forests is the much slower rate of longleaf growth while in the seedling stage, leading to the undeserved reputation of being slow to reach timber size (Franklin 1997:5; Landers et al. 1995:42). Longleaf forests are often visibly distinct from slash pine forests in that bunch grasses (especially the wiregrasses *Aristida stricta* Michx. in the north and *Aristida beyrichiana* Trin. & Rupr. in the southernmost areas) are the dominant understory plant of the former while saw palmetto and to a lesser extent gallberry (*Ilex glabra* L.) typically dominate in a slash pine forest. However, recent studies recognize a wide diversity of longleaf ecosystems based on vegetational composition and soil moisture (e.g., Harcombe et al. 1993; Peet and Allard 1993), including a longleaf system with saw palmetto along the northern Gulf Coastal Plain (Peet and Allard 1993:57, 58). Most of Florida's longleaf forests of the Gulf Coastal Plain, including those of southwest Florida were or are probably of the "southern longleaf flatwood" type, described as often including slash pine and saw palmetto in the relatively wetter areas (Peet and Allard 1993:61, 65). Whatever the dominant pine, "natural" flatwoods generally are highly stratified with a high tree canopy (pines drop their lower limbs, sometimes a result of fire) and a low plant understory.

Longleaf pine itself is most readily distinguished from other southern pines by its long needles, 10 to 15" (25-38 cm), and large cones, 6 to 10" (15-25 cm) (Harrar and Harrar 1962:51-60; Little 1980:291; Wahlenberg 1946:3). Longleaf has the potential to live 500 years or more but usually trees are victims of storms, if not humans, long before reaching such an age (Bengtson et al. 1993; Landers et al. 1995:39-40). Compared to other southern pines, longleaf is the most resistant to disease, insects, and rot, adding to its value as timber wood. South Florida slash pine is less resistant than longleaf but more resistant than typical slash pine.

Longleaf pines are intolerant of competition but remarkably tolerant of surface fire; thus, frequent—at least once a decade and optimally every 2-3

years—low-intensity fires are the key to controlling the growth of competitors such as hardwoods and even slash pines (Abrahamson and Hartnett 1990:132; Landers et al. 1995:40; MacLaren and Stevenson 1993:407; Rebertus et al. 1993). South Florida slash pine is less fire resistant than longleaf but more fire resistant than typical slash pine (Abrahamson and Hartnett 1990:112, 131; Snyder et al. 1990:259). Along with fallen pine needles, highly flammable wiregrasses (Moore 1996a:18; Peet and Allard 1993:46-47) and saw palmetto (Arahamson and Hartnett 1990:129) provide fuel for the fires, usually ignited by lightning strikes. In the absence of human influence (either Indian or EuroAmerican), fires would have been seasonal, primarily limited to the summer lightning season of April to mid August (Myers 1990:185). In pre-EuroAmerican times, a single-ignition fire could burn extensively without the limitations of roads and other human-made barriers. The pines themselves withstand fire in part because of their multi-layered fire-resistant bark (Snyder et al. 1990:259). Longleaf seedlings also regularly survive fire; the seedlings of south Florida slash pine have a lower survival rate yet fare better than those of typical slash pine (Small 1930:42; Snyder et al. 1990:259). Thus, longleaf and South Florida slash flatwoods are especially fire-maintained and fire-dependent. A high frequency of 2 to 3 fires a year would enhance and expand longleaf stands (Rebertus et al. 1993) and slash pine stands as well. In addition to reducing woody competitors, fire contributes to the germination of seeds (especially of longleaf and the understory grasses) by producing appropriate soil conditions; to turnover of litter, humus, and nutrients; and to increased vigor of some species populations (Abrahamson and Hartnett 1990:129; Myers 1990:178).

In addition to wiregrasses, a high diversity of fire-adapted groundcover plants in both longleaf- and south Florida slash-dominated flatwoods sustains a diverse animal life (Abrahamson and Hartnett 1990:116; Engstrom 1993; Guyer and Bailey 1993; Johnson 1995; Moore 1996b:19). This is in part because many of the fire-adapted plants produce new growth, providing food, soon after a fire has burned through the forest. Pine seeds also provide food for many birds and small mammals (Frost 1993:31; Wahlenberg 1946:179). Gopher tortoise (*Gopherus polyphemus*), box turtle (*Terrepene carolina*), eastern diamondback rattlesnake (*Crotalus adamanteus*), black racer (*Coluber constrictor*), pine woods tree frog (*Hyla femoralis*), great horned owl (*Bubo virginianus*), bobwhite quail (*Colinus virginianus*), red-cockaded woodpecker (*Picoides borealis*), turkey (*Meleagris gallopavo*), fox squirrel (*Sciurus niger*), and white-tailed deer (*Odocoileus virginianus*) are some of the animals native to the flatwoods. Most, if not all, benefit from periodic fire. For example, gopher tortoises, more typical of high pinelands (Myers 1990:186) but also present in the drier flatwoods and scrubby flatwoods (Abrahamson and Hartnett 1990:119), cannot survive dense woody vegetation. The underground burrows of tortoises serve as fire refuges not only for the tortoises but also for over 300 other vertebrate and invertebrate animals (e.g., Dodd 1995; Folkerts et al. 1993:165-166, 181-182; Myers 1990:186). Early EuroAmerican observers also recorded bison, black bear, panther, red wolves, and even elk in the longleaf forests of the Southeast (Engstrom 1993:128).

Today there is general agreement among researchers that pre-EuroAmerican pine forests differed from most present-day ones in that they had higher fire fre-

quencies, more uneven age structure, and a more open understory with greater grass components and less shrub plants (Abrahamson and Hartnett 1990:104). Researchers also agree that the reduction of fire frequency may be responsible for much of the difference (Abrahamson and Hartnett 1990:104; Frost 1993:21, 34-35).

The American Indian Factor.—The occurrence and distribution of woodlands (pine and mixed hardwood) and other plant communities and how they changed throughout pre-EuroAmerican history are increasingly being linked to human influence, and in particular to human use of fire (Delcourt and Delcourt 1997, 1998; Delcourt et al. 1998; Pyne 1998). While there are many reasons recorded in historic accounts (Wagner in press) for why American Indians set fires in eastern North America, perhaps two of the most important ones were to stimulate browse plants for attracting wildlife and to drive game. While traveling in north Florida, Bartram (1791:139) stated that "fires are set almost every day throughout the year in some part or other, by the Indians, for the purpose of raising the game, as also by the lightning." Attracting wildlife may have been the primary reason for American Indian management of Florida's pine flatwoods, especially in pre-agricultural times (generally before A.D. 1200 in north Florida). In south Florida where crop agriculture was not practiced, attracting wildlife and improving visibility for hunting undoubtedly would have been the primary reason for setting fires. White-tailed deer and other game animals of the pine forests are highly visually oriented, needing to see their surroundings (Johnson 1995:29).

To date, little research has focused on American Indian use of woodland fire in Florida. One study by Kalisz et al. (1986), however, identified a spatial correlation between archaeological sites associated with non-agricultural Indians and present-day longleaf stands (occurring as "islands" in a landscape of predominantly sand pines) in north-central Florida's Ocala National Forest. In addition, quantification of wiregrass phytoliths in the soils beyond the present-day longleaf stands strongly suggests that they were once more extensive. Kalisz et al. (1986:191) hypothesize that "the longleaf pine islands were maintained through annual or frequent burning by early humans; longleaf pine islands are prehistoric cultural features." Change in the natural fire regime of either sandhill pine stands (as in the Ocala case) or pine flatwoods due to an increase in the number of fires and the addition of a second burn season (winter dry season), if maintained, would have resulted in forest expansion, especially where longleafs or south Florida slash pines were present.

Fifty-six years earlier, in his study of south Florida slash pine "islands" within the Everglades ("Everglade Keys"), botanist John K. Small (1930:41-42) hypothesized about the ecological influence of American Indians:

> ...when the aborigines first occupied the Everglade Keys, they doubtless found them clothed with hammock. ...without doubt, the aborigines purposely set fire to the hammocks in order to drive the game into the open places, thus facilitating their primitive means of hunting game. ... But there had been developed plants that were fire-proof, so to speak, just for such regions...the Caribbean-pine (*Pinus caribaea*)...the seedling pine-trees after several years of uninterrupted growth will survive fire, and when a little

older they are normally perfectly fire-proof. Thus the pinewoods were developed and have spread as the hammock retreated.

DEFORESTATION OF THE SOUTHEASTERN AND SOUTH FLORIDA PINE FLATWOODS

Human-related factors involved in the complex process of pine deforestation include American Indian agriculture, introduced European animals, the naval-stores and logging industries, EuroAmerican agriculture, and reduction of fire. Both American Indians and EuroAmericans contributed to the landscape change, although clearly the latter played the greater role. Importantly, African Americans, masked by the EuroAmerican economic histories, comprised the greater percentage of the labor force for EuroAmerican southeastern agricultural production and for the naval-stores and logging industries.

American Indian Agriculture.—In prehistoric times, agricultural American Indians may have cleared portions of the more fertile flatwoods but no attempts have been made to estimate how much pineland was impacted in the southeast region. Studies that identify and estimate agricultural lands surrounding large Mississippian-period population centers are on the increase, but so far these have focused on areas outside of the longleaf and slash pine ranges (see summary in Wagner in press). Frost (1993:28) notes that Alabama Indian farmers may have cleared much longleaf pineland for their extensive agricultural fields. Many towns of these Mississippian-period agriculturalists were palisaded, representing an additional impact on forests (Wagner in press), possibly including pinelands. Moreover, palisades were replaced, sometimes several times over the occupation of a site. Alabama's Moundville, for example, was palisaded at least three times using a minimum of 10,000 logs each time (Scarry and Steponaitis 1997). Maize agriculture spread throughout north and central Florida after about A.D. 1200 and may have impacted pinelands of these subregions. South Florida's prehistoric Indians, on the other hand, did not practice agriculture.

Introduced European Animals.—Except for the possibility of Indian agriculture as a significant factor, one might argue that the pine deforestation process, in a broad sense, began in 1539 with the Spanish expedition led by Hernando de Soto (Smith 1968). De Soto entered the Southeast in west central Florida and brought with him a food supply that included droves of pigs (Milanich and Hudson 1993:38), herding them along the exploration route throughout much of the southeastern range of longleaf and slash pines. In addition to the resultant, immediate short-term foraging and grazing of the forest groundlayer, unknown numbers of pigs are believed to have escaped, forming the basis for a non-native feral population, one that proliferated in the pine flatwoods. The use of pinelands for grazing continued and diversified when an area's first EuroAmerican settlers learned—perhaps from American Indians—that purposely set surface fires in the woods, especially those with longleafs and south Florida slash pines, reduced the shrub layer (saw palmetto, etc.) and produced new grass forage for their grazing animals. Romans (1775:16) wrote of the north Florida longleaf forests "that immense stocks of cattle

are maintained, although the most natural grass on this soil is of a very harsh nature, and the cattle not at all fond of it, it is known by the name of wire grass; and they only eat it while young...the woods are frequently fired, and at different seasons, in order to have a succession of young grass." The periodic burning of the forest floor by Indians and EuroAmericans benefitted the forests as did fires ignited by lightning, and especially in the case of longleaf and south Florida slash pine forests, perhaps even expanded them if their burning episodes represented an increase in overall fire frequency. However, there was generally an important difference between Indian and EuroAmerican forest management. Prehistoric and many historic-period Indians "fire-managed" pine forests primarily to increase the abundance of native wildlife which they hunted for food. Although grasses, wildlife, and fire were elements of the native flatwoods ecosystem, EuroAmerican livestock was not. Feral and domestic hogs and cattle and even sheep and goats (in some areas), free from fencing as late as the 1950s in south Florida, fed on the many grasses and pine seedlings in these open woodlands (Sargent 1884:492). Departing from the pattern, however, historic-period American Indians in Florida, notably the Seminole, also engaged in cattle-raising on the open range, first in north and central Florida and later in south Florida. Great numbers of feral cattle, many from Spanish origins, roamed the pinelands free for the taking.

The feral hog population had reached a saturation point across most of the longleaf range by 1850, and probably earlier although pre-1840 documentation doesn't exist (Frost 1993:32). While the grasses may have benefited from hog and cattle grazing, the collective rooting, grazing, and trampling of the non-native animals proved to be too much for the pine seedlings, especially those of the slow-growing longleafs. It is reported that a single hog in one hour can root as far as 30 feet, eating some eighty starch-laden longleaf seedlings (Walker 1991:129, 192-193). Thus, feral hogs, in particular, were responsible for the destruction of countless longleaf seedlings, preventing forest regeneration (Frost 1993:30-34; Schwarz 1907:94; Wahlenberg 1946:178-179). In addition, soil compaction and trampling caused by these animals contributed to the inability of seedlings to survive (Abrahamson and Hartnett 1990:146).

South Florida was still in many ways a frontier during the first half of the twentieth century. For example, many south Florida cattlemen continued centuries-old burning practices in the pine woods so that their stock could graze on new grass growth (Akerman 1976:246-247; Franklin 1997:19; Zeiss 1983:118-119), a practice that was compatible with pine forests if seedlings survived their fire-intolerant stage. Wild pigs, on the other hand, still very populous in the 1940s and 1950s in south Florida, continued to consume pine seedlings in massive quantities, significantly impacting the region's source of forest regeneration.

Naval Stores and Logging.—EuroAmerican settlers soon realized more lucrative uses for the longleaf and slash pine forests. The naval-stores industry faced trees (as many as three or four sides of mature trees) and attached cups or boxes to collect resin that was used for the production of rosin, pitch, tar, and turpentine (Butler 1998; Frost 1993:24-27; Mohr 1896:69; Wahlenberg 1946; Walker 1991:77, 146-151). The first three products were enormously important to the shipbuilding industry, while the numerous uses for turpentine varied from lamp oil to laxatives. The

1834 introduction of the copper still for turpentine distillation resulted in a proliferation of turpentine operations (Butler 1998:72-73; Frost 1993:26-27). The still allowed the resin to be reduced to turpentine at the extraction sites and thus saved significant shipping costs. Mature stands of longleaf often produced for only about four years (Mohr 1896:70). Pine trees tolerated extraction of resin but were weakened significantly and thus became more vulnerable to fire, insects, and storms (Mohr 1896:61, 72).

The most lucrative and most destructive of all the pine industries was timbering. The tall, straight longleaf pines with their rot- and insect-resistant wood, for example, made excellent ship masts, long-lasting dock pilings, and when milled, made beautiful homes. Southern longleaf pine, in general, had the reputation in European, Caribbean, and South American markets of being North America's strongest wood due to its density (Mohr 1896:53). Initially, transporting longleaf and slash pine logs to the mills was a slow and difficult task. Logs were floated via natural and human-excavated waterways to mills; thus, the area of forest that could be logged was limited to that which had access to the waterways.

That limitation vanished with the nineteenth-century arrival of the steam-driven locomotive and railroads to the southeastern forests. In addition to the locomotive, steam-powered log skidders, sawmills, and circular saws contributed significantly to the new logging technology. Almost as soon as the main rail lines were laid by railroad companies, lumber companies leased logging rights or bought extensive acres of forested lands adjacent to the lines. Logs were taken from the woods to the sawmills by railcars pulled by a steam locomotive. Due to this acceleration of the logging industry based on steam technology, most of the region's remaining old-growth longleaf and slash pine forests were clearcut between 1870 and 1920 (Frost 1993; Wahlenberg 1946). Just as EuroAmerican settlement had been late coming to Florida, especially the southern half of the peninsula, the state was late in receiving attention from the railroads. The logging of south Florida's pine forests began in the 1920s. Old-growth pines were still being logged in this subregion in the 1950s although much of the focus had shifted to cypress in the Big Cypresss Swamp and Fakahatchee Strand (Tebeau 1957).

EuroAmerican Agriculture.—Before broad-scale logging, many pinelands were cleared by EuroAmerican settlers for the purpose of establishing agricultural fields. Much of the landscape across the region was converted to cotton plantations in the 1800s. Later, especially after 1940, many logged pinelands and old plantation lands were planted in slash or loblolly pines. Slash (primarily the typical *P. elliottii elliottii*) and loblolly were thought to be fast-growing (due to their early rapid growth) compared to the longleaf, and thus were considered more economical to grow, ignoring the higher quality of longleaf wood. Dense plantations of slash and loblolly, with trees planted in neat rows, became the accepted management approach in forestry practices on public-, industry-, and other private-owned lands. In still other areas of the Southeast, including parts of south Florida, citrus groves and non-woodland cattle pastures replaced the old-growth flatwoods.

Reduction of Fire.—The reduction of fire frequency in the Southeast's pine forests intensified with the progression of EuroAmerican settlement. As roads and agri-

cultural fields became more numerous, the pine woodlands became more fragmented, requiring a higher frequency of fire ignitions to burn large areas. Prior to fragmentation, a single lightning ignition could burn extensively across the landscape. With fragmentation, fire was effectively eliminated from many parcels of pine forests (Frost 1993:34). Thus, early fire suppression was perhaps an unintentional result of EuroAmerican settlement. Many of the logged Southeast lands, including longleaf woodlands, experienced serious erosion and flooding (Walker 1991:170-175). This situation, combined with poor agricultural practices, led to the Southeast's navigable rivers being muddied and even clogged. As a result, the federal government began in 1911 to buy the logged lands to protect the Southeast's watersheds. In this manner, over 10 million southern acres were added to the National Forest system, and trained foresters took on their management (Walker 1991). Nonetheless, many millions of acres, especially those forestlands that supported longleaf pine, were not allowed to regenerate naturally.

Perhaps the most critical barrier to regeneration was what might be called the "Smokey Bear Myth." Although purposeful fire-suppression steadily followed the progression of EuroAmerican settlement, the U.S. Forest Service's Smokey Bear campaign, culminating in the 1950s, left no doubt in the minds of Americans that all forest fires were destructive and dangerous, and were not to be allowed under any circumstances (Landers et al. 1995:41; Moore 1996c:22; Walker 1991). Because foresters did not understand the beneficial role of frequent surface fires (e.g., Mohr 1896:62), they unknowingly contributed to the degradation of the pine forests. Without frequent surface fire, the forest floor became thick with pine needles and cones and the shrub layer grew dense, all providing fuel for highly destructive fires when fires did occur. Without fire, the longleaf pines were eventually out-competed by other pines and hardwoods, the slash pines were often out-competed by hardwoods, and the various understory plants and animals specifically adapted to the longleaf and slash forests declined in abundance (Peet and Allard 1993:46). Even in the relatively remote rock pinelands of today's Everglades National Park, twentieth-century fire suppression resulted in a reversal of Small's (1930) hypothesized scenario in that a succession toward hardwood hammock has occurred (Hofstetter 1974:203).

DEFORESTATION OF SOUTHWEST FLORIDA'S PINE FLATWOODS

Archaeological Survey and Historical Research of the HCMP.—During January of 1996, Robin Denson (Gulf Archaeology Research Institute) and I conducted an archaeological survey on a tract of Lee County-owned land just south of the Caloosahatchee River and east of Fort Myers in southwest Florida (Figure 1 inset) (Walker et al. 1996). Prior to and during this same time, I also conducted historical research and a series of interviews with long-time local residents. Much of the area today is characterized by seasonally wet south Florida slash pine/saw palmetto flatwoods and dense saw-palmetto prairies. The county property, known as "Hickey Creek Mitigation Park" (HCMP), was named for Hickey's Creek (after nineteenth-century settler Dennis O. Hickey) which runs through it toward the Caloosahatchee. In part, the park is intended to be a preserve for gopher tortoises in perpetuity to

offset tortoise habitat destroyed elsewhere in southwest Florida (Roger Clark, personal communication, 1996; Riley et al. 1993), hence, the use of the word "Mitigation."

Our archaeological survey documented five American Indian archaeological sites on the park property. Artifact collections include primarily a few pottery sherds, one bone pin, and one bone point; no other faunal remains or other datable organic materials were found. The sherds are all of the Sand-tempered Plain type, also known as "Glades Plain," and are only roughly diagnostic of time period. Because they are not very thick, a post-A.D. 500 date is suggested. These are all small sites and four are associated with the banks of Hickey's Creek (Walker et al. 1996). One site tenuously was based on a single chert flake likely produced from working or reworking a projectile point. Unlike other sites, it is located in the middle of today's slash pine/saw palmetto flatwoods. Larger sites are reported for the mouth of Hickey's Creek on the Caloosahatchee River and just to the south of the park property on Hickey's Creek. The latter produced a relatively large sample of pottery sherds that suggest a post-A.D. 500 habitation, more long-lived than the small sites within the park. It is possible that all sites are contemporaneous. The two large sites may have been the main habitation villages for the area while the smaller creekside sites may have been short-term hunting/fishing camps. The chert flake may have been lost during a hunting episode in the flatwoods. The bone point also suggests food procurement, associated with either fishing or hunting. Freshwater and periodically estuarine fishes would have been available in Hickey's Creek and white-tailed deer, raccoon, opossum, turkey, gopher tortoise, quail, and other game animals would have inhabited the flatwoods, all offering substantial food resources for the Indian residents.

The EuroAmerican homesteader of the Hickey's Creek area was Dennis O. Hickey (Little in Walker et al. 1996:Appendix A) who during the post-Civil War decades farmed, growing "large crops of cabbage, eggplant and squash" (Grismer 1982:109), "raised" cattle in the woodland tradition and also operated a store in Fort Myers (Little in Walker et al. 1996:Appendix A). Also, during the period of 1870-1926, cattle drives (Dodrill 1993:10), some led by Hickey, regularly pushed through both the Hickey's Creek (Little in Walker et al. 1996) and Cape Coral (Zeiss 1983:26; 111-113) areas grazing and trampling in the pine woods on their way to Punta Rassa where the animals were then shipped to Cuba. Hickey's descendent, Mrs. Beverly Little, believes the location of Hickey's home, however, was beyond the boundaries of our survey parcel.

The park includes the archaeological remains of a logging rail system, two logging camps, and associated refuse dumps, all dating to the 1930s and 1940s. Only the younger of the two camps had been recorded with the Florida Site File. Our primary informant, Mr. Dan Garner (Figure 2), told us that an earlier, 1930s camp and rail line had existed, and he took us to this location in what today is a dense, high saw-palmetto prairie (Walker et al. 1996:Appendix D). There, the survey crew found a few surface artifacts reflecting the decade.

We soon learned that the Hickey's Creek area was an important part of what once was an extensive logging network run first (1924-1929) by the J. W. McWilliams Lumber Company and later (1929-1944) by the Dowling & Camp Company (Pickens

in Walker et al. 1996:Appendices B and C). Two brothers, William and James, were sons of Thomas Dowling, who ran a logging operation in north Florida along the Suwannee River centered at Dowling Park (Anonymous 1988; Doris Dowling Crews, personal communication, 2000). Vaughn Camp was of the Camp family, which centered its extensive operations in Franklin, Virginia (Rouse 1988). Dowling and Camp's logging network included what are today two major population areas of Lee County—Cape Coral and Lehigh Acres—the former located on the north side of the Caloosahatchee and the latter located just to the south of Hickey's Creek.

At the beginning of the HCMP survey project, we assumed that only south Florida slash pine had been logged from the Hickey's Creek and Cape Coral areas. But after our initial historical and oral history work, we began to consider that the logged forest adjacent to and south of Hickey's Creek also may have included significant longleaf pine and wiregrass components (Walker 1997; Walker et al. 1996). Both areas share in large part a common soil association, the Pineda-Boca-Oldsmar, which falls into the category of nearly level, poorly drained, deep sandy soils with a pine flatwoods association (USDA SCS 1984).

Despite the poorly drained soil association, the land south of the river was recorded by Vignoles as "high pine" land on his 1823 natural history map of Florida. He typically used "high pine" to refer to longleaf pinelands similar to its use today (Myers 1990:153, 174). Botanist John Harshberger (1914) was more explicit when he stated that longleaf occurred mixed with the more dominant south Florida slash pine, both north and south of the Caloosahatchee. Efforts to locate company records that might more clearly identify the species of logged pines—through

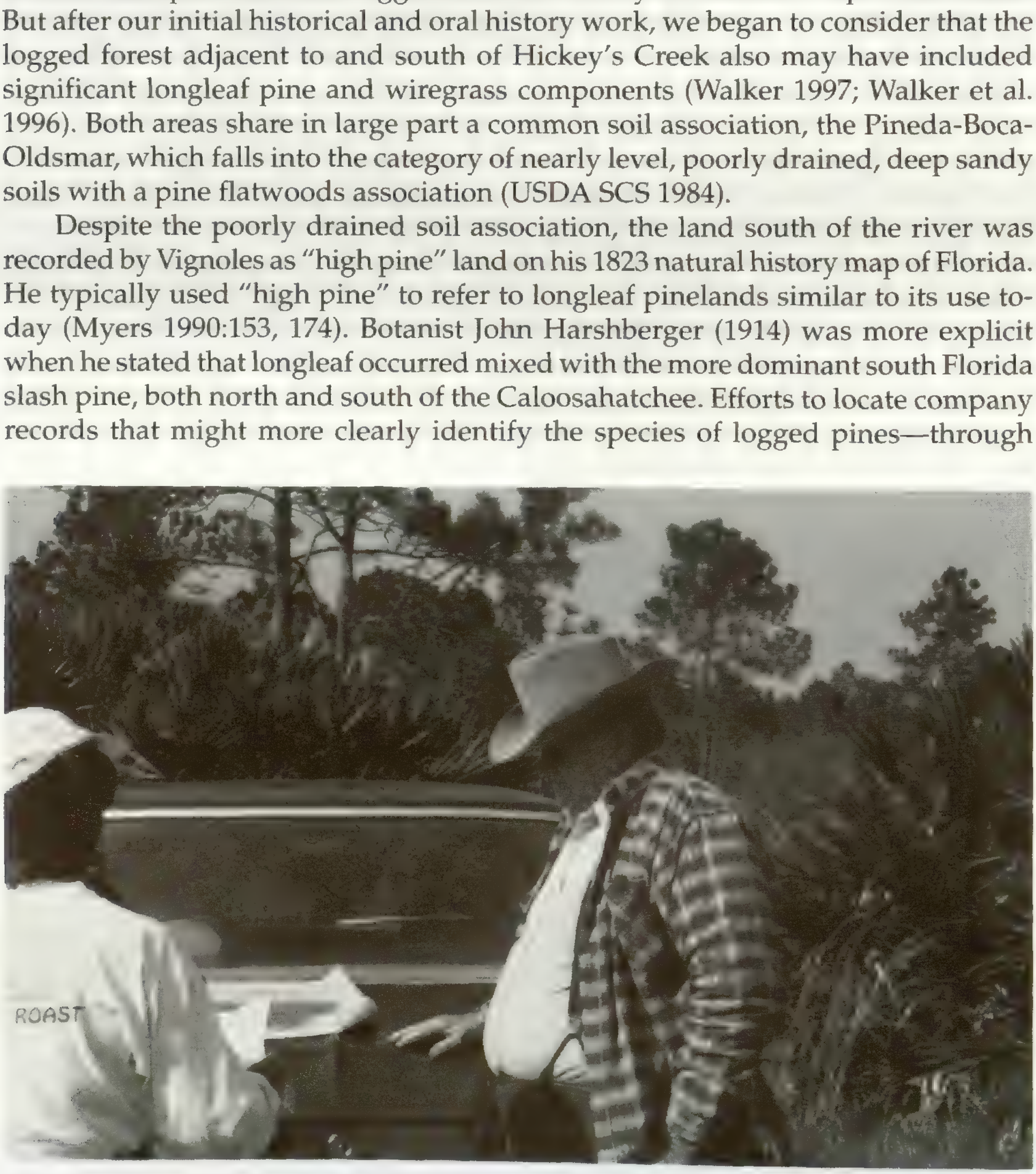

FIGURE 2.—Author's primary informant, lumberman and cattleman Mr. Dan Garner of Alva, Florida, was interviewed in January of 1996 near Hickey's Creek.

Dowling relatives and other avenues—were unsuccessful. A Fort Myers 1926-1927 telephone directory listed the McWilliams Company as manufacturers of "Rough & Dressed South Florida Dense Long Leaf Yellow Pine" lumber (Walker et al. 1996:47). During the time of this listing, the McWilliams Company was logging Cape Coral (Zeiss 1983:98-108). Interpretation of the listing is not straight-forward. Both south Florida slash and the longleaf pine produced wood that was more dense than the northern slash pine. Might McWilliams have been advertising both south Florida slash and longleaf pine with no distinction, in light of Harshberger's mixed longleaf/slash record for Lee County and Wahlenberg's (1943:268) point that high quality pine wood was often sold as "longleaf," regardless of species? The name "longleaved yellow pine" is listed by Mohr (1896:13) as one of the common names for longleaf and thus suggests that at least some of the Cape Coral pine was longleaf. And furthermore, Sudworth's map records the presence of longleaf in the Hickey's Creek area but only slash pine to the south in the Lehigh Acres area, suggesting a longleaf component there. It is probably no coincidence that the areas targeted for logging first by McWilliams and later by Dowling and Camp were areas indicated on Sudworth's U.S. Forest Service map as including longleaf pine.

A lifelong local resident, lumberman/cattleman Dan Garner (Walker et al. 1996:Appendix D) (Figure 2), during the archaeological survey, described the old-growth forest just south of the Caloosahatchee at Hickey's Creek:

> That was the most beautiful pine you ever seen in your life. You just go out there, and you could see a turkey and anything else...there weren't no weed, no palmettos, no nothing. Heart pine. Big heart pine. ...it wasn't near this rough [with high saw palmetto like today]...lots of tortoises and hogs out here...deer, turkey, bobcat...when I was a boy, this was the best place in the world...you could kill all the game in the world.

Unfortunately, Mr. Garner and other local residents of the area knew these pine trees only as "heart pine" or "yellow pine." (Mr. Garner intended to take me to see a mature pine forest in the Lake Okeechobee area—one that is very similar to how he remembered Hickey's Creek's old-growth forest, but he died before we could go.) The same common-language problem is true of the Cape Coral oral histories that Zeiss (1983) collected. The phrases "virgin pine," "first growth trees," and "heartwood" appear throughout—but no mention of species. Most of Cape Coral was described as "high pineland" by early residents (Zeiss 1983:180).

The pre-logged areas of Cape Coral and Hickey's Creek may be characterized best by seasonally wet mixed south Florida slash and longleaf flatwoods. The wetter Lehigh Acres locale probably supported mostly slash pine and both the Hickey's Creek and Lehigh Acres locales included some areas of pond cypress wetland. Based on Sudworth (1913) and Harshberger (1914), Lee County's pre-logged flatwoods, while many included longleaf, were dominated by the south Florida slash pine. This characterization is a revision of my earlier hypothesis of longleaf-dominated flatwoods for northern Lee County (Walker 1997; Walker et al. 1996).

Cape Coral and Hickey's Creek/Lehigh Acres Logging Operations.—Typically, lumber companies clear cut southeastern old-growth pine forests, moved on to the next

FIGURE 3.—Photograph taken in north Florida of a mule-drawn high-wheeled log cart (with a longleaf pine log) fitting cattleman Mark Bateman's description of the circa-1940-1944 carts at Hickey's Creek.

area to be logged, and sold the logged land as soon as possible. The Cape Coral and Hickey's Creek/Lehigh Acres operations followed this pattern. Once the Atlantic Coast Line completed a line to Fort Myers and later the Seaboard Air Line Railway Company completed a line from Fort Myers east into interior south Florida (Grismer 1982:233-234; Turner 1999:33-36; Walker et al. 1996:Appendices B and K), nearby pinelands were purchased or leased by the lumber companies. McWilliams began logging in 1924 and cut pine to build a large sawmill and houses at Slater (Zeiss 1983:99) in what is now North Fort Myers (Figure 1, inset). McWilliams and, after 1929, Dowling & Camp logged the pine flatwoods of Cape Coral. Dowling & Camp later logged the pine flatwoods of the Hickey's Creek and Lehigh Acres areas from 1932 to 1935 and 1940 to 1944 (Walker et al. 1996). The intervening years were spent logging an area in neighboring Hendry County also on the south side of the Caloosahatchee River. This may be in part a locale depicted by Sudworth (1913:Map 35).

Company rail crews laid "spurs" into the pine flatwoods; the rails were laid on ties hewn from pine. A logging crew of about 100 men cut 100,000 board feet a day, about 800 to 1,000 trees a day in the Hickey's/Lehigh area (Garner in Walker et al. 1996:56:Appendix D). Estimates of 50,000 to 120,000 board feet a day are reported for Cape Coral (Board and Bartlett 1985:115; Zeiss 1983:100). Trees were felled by axe or reciprocating saw and logs were chained to high-wheeled carts, and then pulled, dragging one end, by teams of mules to the rail spur (Figure 3). Cattleman Mr. Mark Bateman (Walker et al. 1996:Appendix H), a local resident, recalls the scene from his youth:

> What I was impressed with — because as a young kid, watching the mules pull the logs out to the road...all the leather and chains [of the big-wheel log carts] and everything going together and hearing the mule skinner with the whips and what have you. ... they had the big chain wheels, you know, so high...sand wheels and they'd back over the logs. ... They had the steam engine. ... But they snaked everything to the edge with mules. ... That was something to see. I can hear it and see it just as plain as you and I talking right now.

The 1940s logging episode saw the addition of at least one Caterpillar tractor, operated by Mr. Garner, to the Hickey's/Lehigh operation (Garner in Walker et al. 1996:Appendix D); one artifact collected during the archaeological survey is a ca. 1940s Caterpillar clutch disc. Mules, however, continued to be the primary haulers of logs out of the woods. Mr. Garner also noted the addition of an electric saw toward the end of the operation, ca. 1943-1944. Logs were loaded onto flatcars using steam-powered draglines and a company-owned steam locomotive (fueled by pine slabs) then pulled the logs to Slater Mill. At one time, Dowling & Camp operated with ten locomotives. In 1944, seven remained. Engine #103 (Figure 4) was used to remove logs from the Hickey's/Lehigh area, taking them to Slater.

As soon as an area was "cutover," rail crews picked up the iron spurs and relaid them in new, uncut areas of forest (Garner in Walker et al. 1996:Appendix D; Zeiss 1983:102). The railroads and their rail spurs, even when taken up, left visible grades, especially in south Florida where beds often were raised to avoid the sea-

FIGURE 4.—Dowling & Camp's Engine 103 hauled pine logs from the Hickey's Creek operation to the mill at Slater. Photo courtesy of James Pickens.

sonally flooded lowlands. The grades are usually paralleled by excavation ditches as is the case at Hickey's Creek. Lost railroad spikes and spent ties are often found in the ditches. In addition, as the logs were dragged from the woods, they left linear "scars" in the ground, all leading to the closest rail spur. Studied from aerial views, the spurs and log scars can be traced, revealing dendritic or feather-like patterns (Pickens in Walker et al. 1996:Appendix B). A series of aerial photos taken in 1944 covering the two Lee County areas documents the spurs and log scars, which allowed Mr. James Pickens to reconstruct the logging system (Figure 1, inset). The feathery patterns show the two major components of the system. The eastern Hickey's/Lehigh component is the smaller of the two. The larger, western, Cape Coral component originated at Slater Mill where logs from both areas were milled until the mill and all logging closed down in 1944 (Board and Bartlett 1985:115; Godown and Rawchuck 1975:108; Walker et al. 1996:Appendix F; Zeiss 1983:99).

Cape Coral and Hickey's Creek Logging Camps.—Temporary camps for the logging and rail crews and their families were established in the woods. Typically, only one woods camp would exist at a time. Zeiss interviewed several individuals who remembered various camps in the Cape Coral area. Locations for at least four camps were described (Zeiss 1983:103, 105). One of these consisted of "shacks" and others used boxcars or railroad passenger cars for housing. Detailed memories of the Hickey's/Lehigh logging operation and its camps come from Mr. Garner

FIGURE 5.—Photograph taken in a west Florida longleaf forest shows a boxcar logging camp similar to those described for Hickey Creek circa 1932-1935 and 1940-1944 (mules were used at Hickey's Creek instead of oxen). Photo courtesy of Florida State Archives, Tallahassee, FL.

(in Walker et al. 1996:Appendix D). When about 10 years old, Mr. Garner frequented the ca. 1932-1935 camp and while in his teens he worked with the logging crew of the ca. 1940-1944 camp. Both camps consisted of railroad boxcars serving as year-round, portable homes for the logging and rail crews and their families. Both crews of both camps were African American. The crew supervisors were EuroAmerican and lived in the nearby town of Alva and elsewhere. Mr. Frank Gay at one point supervised the Hickey's Creek crew (Mrs. Serena Gay, personal communication, 1996). A photograph taken in a northwest Florida longleaf forest shows a boxcar logging camp (Figure 5) similar to the one described for Hickey's Creek except that mules were used instead of oxen. The camps had outhouses, and although temporary, the 1940s camp had substantial government [WPA]-built privies with cement foundations.

Both camps had commissaries for purchasing groceries, dry goods, and personal items. The 1930s commissary, like the workers' homes, was a boxcar. This was probably also the case with the Cape Coral camps since there was a large commissary not far away at Slater. The 1940s Hickey's Creek commissary, on the other hand, was a substantial one-story structure built of "heart pine" lumber. Workers were paid with company "scrip" and aluminum tokens, a common practice among logging companies, particularly during the Depression era. Children rode a bus to attend school in Fort Myers. A medical doctor visited once a week from Fort Myers and administered medicines contained in bottles such as those found during our survey (Walker et al. 1996). Mr. Garner describes camp life with images of children, baseball, sour-orange wine, whiskey made from cane-skimmings, and "good times." Vegetable gardens, commissary pork and beef, and local wildlife including gopher tortoises, raccoons, and fish, were central to the diet of the woods community.

Post-Logging Decades.—Like many of the Southeast's pine flatwoods, those of the Cape Coral and Hickey's/Lehigh areas were clear cut. In addition to removing the seed source, the logging activity greatly disturbed seedlings that were present, along with the seedbed itself. Combined with the destructive feeding behavior of feral pigs, the competition from fast-growing oaks, the reduction of fire, the introduction of citrus and other agricultural crops, and open-range cattle grazing, the mixed longleaf/slash pine forests had little opportunity to regenerate. The remaining old-growth pine stumps at Cape Coral were extracted from the land and transported to Mississippi and to Brunswick, Georgia for use in naval-stores products (Zeiss 1983:180). At some point, stumps at Hickey's Creek also may have been taken out (Roger Clark, personal communication, 1996; Riley et al. 1993:22); we observed telltale depressions in the ground during our survey. Taking advantage of the highly desired dense pine to the very end, landowners salvaged the lumber out of the old Hickey's Creek commissary building during the 1950s (Crawford in Walker et al. 1996:Appendix I) to use elsewhere.

For a while, the land that today is the county's HCMP and is largely in south Florida slash pine, scrub oaks, and saw palmetto, was used for cattle grazing by cattlemen, including Mr. Garner. Through the late 1940s, the 50s, 60s, 70s, and 80s, Garner and others conducted burns in order to provide new grass growth for their cattle, a longstanding woodland-grazing tradition (Garner in Walker et al. 1996:Ap-

pendix D). Despite these burns, however, the Hickey's Creek pine forest only partially recovered from the clear-cut logging. During these same decades, feral pigs were still in abundance and citrus groves were planted in some of the area (Little in Walker et al. 1996:Appendix A).

During the 1940s and 1950s, cattle also continued to be an important element of the Cape Coral and Lehigh Acres landscapes but this use of those logged lands came to an end during the latter part of the 1950s. Lee County's human population increased dramatically in the post-war years, a time of housing shortages. And many WWII servicemen who had been stationed in Fort Myers returned with their families to establish new homes. So, not surprisingly, most of the cleared land in the Lehigh Acres locale, first transformed into ranchland, soon (by 1954) ended up under the ownership of a development firm initially called Lee County Land and Title Company, and later, Lehigh Development Corporation (Dodrill 1993:6). The developers' marketing strategy to lure families to Lehigh Acres included a 1961 promotion in which a new home was offered as Grand Prize on the TV show *"The Price is Right"* (Figure 6) (Board and Bartlett 1985:186). Similarly, in 1958, a massive housing development was initiated in the western sector of Lee County's logging system (Dodrill 1993; Zeiss 1983). Today Cape Coral (Figure 1, inset) has become, landwise, the second largest city in area in the south next to Jacksonville, Florida (Gainesville Sun, Sept. 11, 2000).

FIGURE 6.—In 1961, TV game show *The Price is Right* offered as Grand Prize a new south Florida (Lehigh Acres) home located in the logged pinelands that were part of the Hickey's Creek/Lehigh pine logging system. Photo from Board and Bartlett (1985).

SCALAR PERSPECTIVES

Following the introduction of European domestic animals, the degradation of old-growth forests accelerated and largely followed the transgression of non-Spanish EuroAmerican settlement (Frost 1993; Wahlenberg 1946; Walker 1991). The process was slow at first, in the eighteenth century, and intensified with the arrival of railroads in the nineteenth and twentieth centuries that were pushing farther and farther into the southern states. Thus, while southeastern Virginia was the first subregion to lose the longleafs on a massive scale, mostly in the eighteenth century, south Florida was the last, losing its old-growth longleafs and south Florida slash pines in the 1920s through the 1950s.

The local historical ecology of Lee County's pine forests at Cape Coral and Hickey's Creek/Lehigh Acres may be largely typical of the process of landscape change that occurred with other south Florida pine forests. One important difference, however, stands out. The majority of Lee County's pre-EuroAmerican pine flatwoods may have been characterized by a mixture of south Florida slash and longleaf pines, with longleaf representing the southernmost limit of its range. It may be more appropriate to conceive of two south Florida subregions in terms of pine forests. One is the transitional south Florida where longleaf diminishes in dominance, mixes with south Florida slash until a point is reached when only slash occurs. The latter situation of "pure" south Florida slash flatwoods is the second south Florida subregion.

The reconstructed pre-EuroAmerican composition of south Florida's pinelands is in reality nothing more than a reconstruction of one ecological episode in the historical continuum. Representing today's southernmost extent of longleaf, this marginal subregion is the ideal area to test for the long-term climatic episodes—commonly known as the Roman Optimum, Vandal Minimum, Warm Medieval Period, and Little Ice Age—of the past two millennia. During the cooler/drier periods (VM, LIA), longleaf may have expanded farther into south Florida while during the warmer/wetter episodes (RO, WMP), longleaf may have retreated north. The nineteenth and early twentieth centuries correspond with the end of the LIA; thus our perception of a reconstructed pre-EuroAmerican forest might better be situated in the LIA, an episode of hypothesized longleaf expansion. And our concept of a twenty-first-century range of south Florida pine flatwoods and their composition might better be situated in our current warm and wet trend with a hypothesized retreating longleaf distribution. Unfortunately, tracking of fluctuating pine forest composition through time awaits the development of methods to identify the archaeological and paleoecological remains of longleaf versus slash pine.

At the local scale, the historical ecology of Lee County's pinelands is generally similar to that of the greater southeastern Coastal Plain region, but important differences exist. First, although it remains to be tested (if possible), I hypothesize that like many subregions of the Southeast, Lee County's American Indians fire-managed their local pine flatwoods. However, whereas in other areas of the Southeast, clearing for agriculture by American Indians may have been a factor, it wasn't in south Florida. Rather, here the purpose likely would have been for maintaining game populations, especially those of white-tailed deer.

The impact of cattle and especially pigs may have been longer, extending later in time in south Florida than in other southeast subregions. Still the frontier in the nineteenth and early twentieth centuries, south Florida continued its open-range tradition (historic American Indian and EuroAmerican) and cattle drives (EuroAmerican) through both the Cape Coral and Hickey's/Lehigh locales on the way to Punta Rassa for shipment to Cuba as late as the 1920s. Even so, it might be argued that cattle and pinelands may have been compatible rather than in conflict with the pinelands. Although today most of the cattle industry exists to the east in interior lands of south Florida, feral pigs are still a challenge for management and restoration of the HCMP pinelands.

One element in the broader-scale Southeast trajectory that may be largely missing from Lee County's forest history is naval-stores production. Despite the fact that the Hickey's Creek property at one time was owned by Consolidated Naval Stores Corporation (Walker et al. 1996:69-70), I found no record or memory of actual turpentining. Zeiss's (1983:98) explanation for the absence of turpentining in the Cape Coral area is that the pines were more valuable as lumber for building material because it "was loaded with pitch, which served to protect it against dry rot as well as from invasion by termites." Perhaps by the time broad scale industrial exploitation of forests reached south Florida, the importance of turpentining had faded and clear-cut logging was economically more desirable.

Another difference is that fire suppression may not have been as important a factor in the inability of the Cape Coral and especially Hickey's Creek forests to regenerate: during the post-logging years, the area's cattlemen regularly burned the logged lands. For Cape Coral and Hickey's Creek, the impact of clear-cut logging (destruction of the seed source) followed by the pressures of cattle and feral-hog grazing, trampling, and rooting, the introduction of citrus trees and other agriculture (in some areas), was too great for any remaining longleaf seedlings. Furthermore, Cape Coral and the southern portion of the Hickey's Creek logging system (Lehigh Acres) were quickly transformed by developers into residential communities. During this time (1950s), however, a close watch was kept and fires were suppressed in the Cape Coral area, as more and more new residents arrived.

Another difference, more temporally related, is that logging everywhere in south Florida was more rapid than in more northern subregions. This was due, at least in part, to advances in logging technology during the 1940s. The operation at Hickey's Creek combined the old ways—axe, mule and cart, railroad, locomotive—with some of the new ways—electric saw, tractor—although the old still dominated. By the 1950s, trucks were regularly replacing the need for railroads and locomotives in some areas of south Florida (e.g., Collier County). Again, we see two south Florida logging histories, one characterized by a transition in technology, the other by an essentially modern technology.

CONCLUSION

What became of the once extensive old-growth southeastern pine forests involved a long process of dynamic interplay between numerous environmental and cultural factors possibly beginning as early as A.D. 800 in some parts of the

region. Generally (i.e., at the long-term regional scale), the same process of landscape change happened across the entire Southeast distribution of longleaf pine. A historical ecology approach to southeastern pine deforestation, however, contributes to the recognition of heterogeneity within the process of this broad-scale landscape change. In particular, examination of the southernmost margin of longleaf clarifies the extent of its pre-EuroAmerican penetration into southwest Florida (at least for the LIA). The study of Lee County's pine flatwoods from a historical ecology approach has resulted in the hypothesis that longleaf pine was a component of Cape Coral's and Hickey's Creek's pine forests. Intergrading with south Florida slash pines, these longleafs would have been the southernmost of their range. Harris (1999) makes the point that south Florida's tropical forests have been under documented and thus under appreciated. The same can be said for south Florida's pine forests.

Southwest Florida experienced the longest history of pre-logging pine deforestation with perhaps one of the swiftest of logging culminations. It was a subregion of transition where longleaf and south Florida slash pines intergraded and where old and new logging technology came together, but also an area where the longstanding tradition of compatible fire-managed woodland grazing persisted into modern decades. To cap the processual continuum, large portions of Lee County's logged old-growth pinelands were transformed into two of the earliest post-war massive suburban housing developments, the beginning of a new era for south Florida—one of enormous human migration to the Florida's subtropics.

Estimates for upland landscape changes are presented by Frost (1993:19-20). An astonishing 85 percent of the Coastal Plain's pre-EuroAmerican uplands included longleaf pines (71 percent consisted of longleaf-dominated uplands). Slash pine, on the other hand, is estimated to have characterized only 3.3 percent of the pre-EuroAmerican uplands. Estimates for 1990 are a stunning 2.6 percent for "natural" longleaf (2.1 percent for longleaf-dominated uplands) and 0.4 percent for "natural" slash pine uplands, with successional mixed hardwood-pine forests (44 percent), croplands (20.8 percent), pine plantations (15.2 percent), developed lands (10.2 percent), and pasture (6.4 percent) having replaced the old-growth native pine forests.

According to a 1995 inventory, longleaf pine acreage continues to decline in the greater Southeast and in Florida (Outcalt and Sheffield 1996:2, 20). Most losses have occurred on privately owned lands. Because remaining stands on private lands are continuing to reach saw-timber size, losses will most probably continue at a high rate. Based on a study of North Carolina longleaf, Frost (1993:21) figures that few existing stands are being fire-maintained and as a result the majority of stands are heavily invaded by hardwood species. If this pattern is typical of the Southeast region, Frost estimates that less than 0.7 percent of the pre-EuroAmerican longleaf forests remains under "natural" conditions. Restoration efforts on county, state, federal, and even some industry and private lands are increasing (e.g., Boyette 1996). However, of the longleaf states, only Texas shows small increases on both public and industry lands (Outcalt and Sheffield 1996:20). No increases are shown for private lands.

Restoration efforts aimed at both longleaf and slash pine forests include new

management plans that emphasize periodic burning of the forest ground layers. Efforts by conservation groups large and small, such as The Nature Conservancy, Tall Timbers Research Station (north of Tallahassee, FL), Longleaf Alliance (Johnson 1996; Longleaf Alliance n.d.) of Auburn University's School of Forestry, and the Longleaf Partners Funds/Longneedle Press (Moore and Goodwin 1995, 1996) and Longleaf Ecology and Forestry Society (LEAFS), both of Gainesville, Florida, are educating the public and landowners of the values of restoring native longleaf ecosystems. For example, a recently published management guide for landowners (Franklin 1997) provides guidelines for burning practices and for compatible timber and cattle production, once again following the centuries-old tradition of pineland grazing. The developing trend in landowner education is the promotion of compatibility between longleaf reforestation and economic viability (e.g., Franklin 1997; Landers et al. 1995). Modern studies show that with appropriate management, overall longleaf growth rates are comparable to the other pines on most lands (Franklin 1997:5).

Southwest Florida's Lee County together with the Florida Game and Fresh Water Fish Commission have initiated reforestation in the new HCMP, planting a mix of south Florida slash and longleaf pines. A restored, fire-managed pine forest would be good habitat for a gopher-tortoise preserve, fulfilling one conservation goal of the HCMP. In addition, an archaeological National Register nomination (for the multiple historic logging sites) and a public education program including on-site ecological and historical interpretation and trails are being considered for the near future.

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Biodiversity and Native America. Minnis, Paul E. and Wayne J. Elisens (editors). University of Oklahoma Press, Norman. Pp 310, x, maps, figures, and illustrations, index. $34.95 cloth. ISBN 0-8061-3232-9.

Biodiveristy and Native America is a significant and essential read for students and researchers interested in past and present environmental relationships among Aboriginal peoples in North America. The book spans most of the geography of the United States, with representative articles covering portions of Mexico and Canada. This book is a beginning of what will hopefully be many books on the subject, the editorial product of Paul Minnis and Wayne Elisens, University of Oklahoma. The papers largely came together as a result of a 1997 symposium workshop organized around the topic of "Biodiversity and Native North America." The book showcases 10 articles reflecting a variety of geographical and cultural perspectives, set in three sections.

Section one: Issues and Overviews contains three articles that examine First Nations' management and conservation (Sonora Desert), ethnobotony (Mexico) and ethnopharmacology (broad U.S. overview with implications for Peru). The first article by Gary Paul Nabhan bridges issues from linguistic anthropology with conservation biology. Robert Bye and Edelmira Linares offer a fine paper summarizing the complex and evolving ethnobotanical relations among the over 54 Indigneous language groups in Mexico. These groups have extensive knowledge for the Holarctic and Neotropic plant kingdoms. Walter Lewis presents an informative, but narrow, discussion of ethnopharmacology and a possible future built on collaborative agreements. Lewis does not discuss how the influence of tremendous amounts of capital on traditional systems, including issues of ownership (is knowledge of medicinal plants individual or collective property), will be worked out.

Section two: Ethnographic Case Studies, gives the greatest representation of "biodiversity and Native America" in this volume. The three papers represent the sampled knowledge of Northern Paiute, Owens Valley Paiute, Southern Paiute, Timbisha (Panamint), Shoshone, Ute, and Washoe; Stl'atl'imx (Lillooet/Lil'wat); and Rarámuri. Catherine Fowler recounts in her paper how fieldwork with Numic speaking Great Basin Indian people in the 1960's and 1970's brought forward the concept "we live by them." This "Native knowledge" may be gathered and focussed as ethnobiological constructs, but it is embedded and expressed in the cultural practices and daily lives of untold numbers of Aboriginal peoples from whom she learned/studied. The article by Sandra Peacock and Nancy Turner is an excellent example of collaborative ethnobotanical research. The authors balance academic/scholarly knowledge with traditional plant knowledge to understand traditional resource management and biodiversity conservation for a portion of the traditional territory of the Secwepemc, Stl'atl'imx, Nlaka'pamux, and Okanagan people. In the third paper in this section, Enrique Salmón examines the Rarámuri concept of iwígara. The paper is a well researched and important paper that made me questions the role of traditional environmental knowledge.

Many of the papers in this edition advocate changing western land management practices and thinking (and I support such efforts). However, if the role of

ancient knowledge really is to reform science and western constructs we need to know how they will and can function within our commercialized modern world. What the potential and real impacts on how the Rarámuri are able to practice iwígara in the northern Sierra Madre Occidental is left unstated. A dominant view among most Indigenous groups is that ancient knowledge has intrinsic and cultural value, which scientists have a hard time understanding and accepting.

Section three, Prehistory and Biodiversity, contains three interesting papers. This section will disappoint those readers who may have grown somewhat accustomed to the culturally specific, situated, and interdisciplinary tone of the volume to this point. The three papers in this section are more general with an over-riding anthropological perspective. Furthermore, the contributions in this section reflect a much narrower geographic focus, which does not fit with the rest of the book. With this said the three papers should not disappoint readers, as they offer significant contributions. Focussing his discussions on Northern New Mexico, Richard Ford examines the significance of human disturbance on biodiversity, arguing that "it is a mistake to regard Native Americans as insignificant managers of biotic resources or as passive participants in the shaping of the landscape and the diversification of habitats" (219). Gayle Fritz describes some inferences available through archaeological research for sites that cover a broad area of the eastern United States and a portion of southern Ontario. Fritz's paper suggests the difficulties that biologists and anthropologists run into when assessing the scale of environmental impacts and changes to anthropogenic influences. Unfortunately, this paper appears to reflect a classical positivist research approach by failing to involve or even consult local knowledge in understanding prehistoric changes. While this may be the least informative paper regarding Traditional knowledge, Fritz is able to dispel myths that Eastern Amerindians were non-agrarian nomadic peoples, and so it is nonetheless an important paper for readers to consider. The final paper in this edition by Julia Hammett, an already published journal article (was originally her master's thesis), examines the ethnohistory of the southeastern United States. Hammett cautions that historical accounts are "loaded with distortions, biases, and contradictions" and suggests that it is important to understand the cultural context of the original authors, an ambitious project to say the least (p. 253). This paper is both informative and provocative and completes the book in a way that urges readers on to further research.

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A CLADISTIC APPROACH TO COMPARATIVE ETHNOBOTANY: DYE PLANTS OF THE SOUTHWESTERN UNITED STATES

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ABSTRACT.—An intensive review of the ethnobotanical literature on dye plants used by 11 indigenous tribes in the Southwestern region of the United States revealed that 108 plants have been used to manufacture dyes for coloring wool, leather, cotton and other plant fibers. Some plant species are also used to obtain pigments for pottery and body paint while others are used to color food. Of the 11 different plant dye traditions evaluated in this study, the Navajos use the greatest number of plants (n=69) for dye purposes. Considering innovations in dye plant traditions shared among tribes to be analogous to shared derived characters in phylogenetic analyses (termed "synapomorphies"), a cladistic analysis shows that traditions of dye plants are most derived among the Navajo and Hopi tribes. The traditions of dye plants of these two tribes are also more closely related to each other than either tradition is to dye plant traditions from other tribes. The cladistic approach of analyzing shared derived technologies appears to be a useful way of generating hypotheses concerning cultural diffusion of plant uses in other ethnobotanical studies.

Key words: cladistics, dye plants, ethnobotany, Southwestern Native Americans.

RESUMEN.—Una revisión intensiva de la literatura enthnobotanical en las plantas del tinte usados por 11 tribus indígenas en la región al sudoeste de los Estados Unidos reveló que 108 plantas se han utilizado para fabricar los tintes para las lanas del colorante, el cuero, el algodón, y otras fibras de la planta. Un ciertas especies de la planta también se utilizan para obtener los pigmentos para la cerámica y la pintura de cuerpo mientras que otras se utilizan para colorear el alimento. De las 11 tribus evaluadas para este estudio, la tribu de Navajo utiliza el número más grande de las plantas (n=69) para los propósitos del tinte. Considerando innovaciones en las plantas del tinte compartidas entre las tribus para ser el equivalente del termo cladistico se dice "synamorphies," un análisis cladistic mostró que las aplicaciones del tribus de Navajo y de Hopi son derivados más de las plantas del tinte. Estas dos tribus también se relacionan más de cerca el uno al otro en sus aplicaciones de la planta del tinte que están a cualquier otra tribu. El acercamiento cladistic de analizar tecnologías derivadas compartidas aparece ser una manera útil de generar hipótesis referentes a la difusión cultural de las aplicaciones de la planta en otros estudios ethnobotanical.

RÉSUMÉ.—Une revue approfondie de la literature ethnobotanique est presenté sur 108 plantes utilisées comme teintures par 11 tribus indigènes à la region suroeste des Etats Unis. Elles sont utilisées pour teindre de la laine, le cuir, le coton, et quelques autres fibres vegetales. La tribu Navajo utilis le plus grand nombre des plantes comme teintures (n = 69). Une analyse cladistique indique que les tribus Hopi et Navajo sont les plus développées en ce que concerne utilization de plantes comme teintures et aussi elles sont plus similares entre se.

INTRODUCTION

The Southwestern region of the United States is considered ethnobotanically to be "the best studied area in the world" (Ford 1985:401). In this region, comprehensive studies have been made of the plants used by indigenous people for medicine, food, clothing, and art (Bell and Castetter 1937; Castetter, Bell and Grove 1938; Dennis 1939; Dunmire and Tierney 1995; Fewkes 1896; Kent 1957; Palmer 1878; Sauer 1950; Standley 1911; Winter 1974). Other studies have focused on the ethnobotany of particular tribes (Castetter and Underhill 1953; Cook 1930; Elmore 1943; Ford 1968; Hough 1897; Jones 1931, 1948; Mathews 1886; Reagan 1929; Robbins, Harrington and Freire-Marreco 1916; Stevenson 1915; Swank 1932; Vestal 1952; White 1945; Whiting 1939; Wyman and Harris 1941, 1951). However, comparative ethnobotanical studies are rare. In the early 1960's, Whiting identified an urgent need for "summary reports, comparative historical studies, and broadly based reviews of comparable data throughout the area" (Whiting 1966:318). Doebley (1984) responded to this call with comparative studies of wild grasses, yet few other similar studies have been done. Twenty years after Whiting made his statement, Richard Ford (1985) and Robert Bye (1985) both noted that there remains a void in the area of comparative work.

We have compared use of plants for dyes and paint among different southwestern indigenous tribes based on historical and contemporary accounts. For this purpose we considered all plants used to color wool, cotton, and leather, for food coloring, as well as for pigments for body and pottery paint. The purpose of our study is two-fold: (1) to provide a comprehensive review and comparison of dye plants used by southwestern Amerindians, and (2) to show how cladistic analyses may be used to generate hypotheses concerning cultural diffusion of plant uses between tribes.

Linguists, systematists, and biogeographers have previously used cladistic techniques to study common origins of languages, biological species, and biogeographical regions respectively. Unlike comparative methods that rely on overall similarity, such as phenetics, cladistic analyses generate relationship diagrams (also know as cladograms) based on shared derived features or characters (synapomorphies). Thus, although phenetic schemes might suggest crocodiles and lizards are more closely related to each other than either are to birds because of overall similarity, cladistic analyses group birds with crocodiles because of shared derived features of skull anatomy (Ridley 1993). In biology, characters used for cladistic analyses can be different features of anatomy, molecular sequence, behavior, physiology and so forth.

We believe that cladistic analysis might be a useful method for cross-cultural ethnobotanical comparisons. A unique technological innovation that is subsequently shared by different cultures could be considered a shared derived feature, called in cladistic terminology a "synapomorphy." For example, if use of a particular plant as a medicine originated with a single individual, but subsequently spread to different cultures through time, that use could be considered to be a synapomorphy for those cultures. Synapomorphies are used in cladistic analyses to indicate possible branching patterns in cladistic trees. Such shared derived innovations can then be used to generate relationship trees for the technology of interest (such as dye plants, medicinal plants, crop varieties, etc.). Diagrams of these relationships, presented as trees, are termed "cladograms."

Technological features in common to different cultures that do not share a common unique derivation could be termed "symplesiomorphies." For example, the use of conifers as firewood is probably common to all cultures where conifers occur, but likely cannot be traced to a single unique innovation, and hence is an example of a symplesiomorphy. Symplesiomorphies unfortunately, are of little or no value in determining relationship trees or cladograms.

Some cultures may produce technological innovations that do not spread to other cultures. Such unique unshared innovations are termed "autapomorphies." For example, use of an endemic species of algae by the Hawaiian people cannot possibly have spread to other islands, and hence could be considered an autapomorphy. Autapomorphies, while interesting for a particular culture, do not shed light on relationships to other cultures.

Characters used for cladistic analyses in cross-cultural ethnobotanical studies could include technological, medicinal, artistic, architectural, ritual innovations. It is not necessary to compare biological entities; we here study plant uses because as ethnobotanists our interests are focused on the interactions between plants and people. Cladistic studies require that observable information is translated into discrete characters (Kitching et al. 1998). In cross-cultural ethnobotanical studies one can easily identify plants as used or not used, making such characters prime candidates for cladistic analyses. Thus, we are proposing to evaluate relationships between uses of plants by different tribes based on shared technological innovations of dye plant use rather than grouping these uses on the basis of overall similarity. It is important to note that we are not, however, attempting to consider genetic or cultural relationships of the tribes themselves. It is only the plant uses, and not the people themselves, which are the objects of our analysis. Thus, while our diagrams of plant use relationships are not intended to suggest genetic or cultural relationships between different tribes, they can be used to generate hypotheses of how different discoveries of new dye plants might have spread through various cultures.

While cladistic techniques are simple, and for a limited number of different traditions of plant use (three or four) can easily be done by hand, the number of possible alternative relationships trees (and hence the number of calculations) increases exponentially with the number of tribes. As a result, we have had to use a computer program to evaluate the number of trees. As will be described shortly, the program basically determines which, of all possible relationship trees, is the

most parsimonious- the one requiring the least number of steps of culture transmission, parallel innovation, and culture loss. This most parsimonious tree is then proposed as a candidate for evaluation by other researchers. Often, with a large number of taxa (here considered to be different tribal traditions of plant dye use), different trees of equal number of steps are discovered during the computer algorithm. We have here chosen to present a summary of the features in which all of these most simple trees agree: such a diagram is called a strict consensus tree. Further information on cladistic techinques can be obtained from a variety of textbooks in systematic biology.

METHODS

General Comparison.—As a means of understanding native American traditions of dye plants use, we conducted interviews with Navajo weavers on the Navajo reservation in Southern Utah and Northern Arizona and observed some collections of dye species and dying techniques. We then expanded our study to a regional basis by conducting an intensive literature review, compiling ethnobotanical information on 11 different tribes: Eastern Keres, Hopi, Jemez (Towa), Navajo, Papago, Pima, Southern Tiwa, Tewa, Western Apache, Western Keres (Acoma and Laguna), and Zuni. We chose to study the dye plant traditions of these tribes because of the geographical proximity of the tribes to each other, their pattern of cross-cultural interactions, and the availability of previous ethnobotanical studies.

Some of the dye plants used in the past are no longer used today, yet for our analysis we include both historical and contemporary uses with no effort to distinguish between the two. In our study we selected from literature accounts only those plants identified to the level of both genus and species, since records from different tribes of a plant identified only by a generic epithet might conflate different species, skewing our analysis. For consistency, plants identified beyond the species level to the varietal level were truncated to species. Appendix 1 lists each plant and the tribes that used it. Figure 1 illustrates approximate tribal boundaries and the number of dye plants used by each tribe. Our definition of tribal boundaries is somewhat arbitrary since these boundaries have never been static but vary in time with changes in culture, modes of transportation, and the colonization/reservation boundaries forced upon different indigenous groups. For this reason, we used a slightly modified version of regional boundaries defined in *The Handbook of North American Indians* (Ortiz 1983).

Cladistic Analysis.—A cladistic analysis based on shared derived characters (synapomorphies), in this case, shared cultural innovations in use of dye plants, was performed by coding each of the 108 dye plant species as either used or not used for each of the 11 tribes. Our data matrix is provided in Appendix 2. No effort was made to differentiate between plants used to dye wool or other materials for two reasons: (1) we are presuming that one plant used for one particular material would most likely be tried on other materials as well, therefore not be exclusive to wool, cotton, leather, or other materials, and (2) literature accounts tend to focus on the plants used rather than on the types of materials dyed. Our coded data

FIGURE 1.—Map showing the geographic proximity of tribal regions. Number of dye plant species used by each tribe are indicated (adapted from Ortiz 1983).

matrix was analyzed with the computer program HENNIG86 (Farris 1988). In the analysis we gave each dye plant species an initial weight of one and selected the non-additive option. The complete search algorithm, implicit enumeration (ie), was used to generate relationship trees of minimal length. A strict consensus tree was obtained for the trees obtained from implicit enumeration of the unweighted characters (Figure 2). We then found equally parsimonious trees by using the *xsteps* command with the *w* option utilized, thus applying species weights according to their fit to the trees. Weights applied were calculated by the program as the prod-

uct of character consistency index, *ci* (Kluge & Farris 1969) and the retention index, *ri* (Farris 1989a, 1989b). Weightings were applied in successive rounds of implicit enumeration until no changes in tree length, consistency index, or retention index could be obtained from successive rounds. We then obtained a strict consensus tree for the weighted sample.

In a strict cladistic sense, we make no claim about the monophyletic nature of the traditions we have here analyzed; in fact the uses we analyze may be paraphyletic because 1) we do not know if all of these plant dye uses can somehow be traced back to a singular innovation in the uses of plants as dyes, and hence share the same ancestral tradition, and 2) it is doubtful if we have here included all possible traditions derived from an ancestral tradition; little is known, for example, about Anasazi use of dye plants.

In cladistic analyses, often an outgroup possessing the "primitive" state is chosen in order to determine character polarities. Not wishing to make any statement about relative age and technological status of any of the 11 tribes we studied by claiming that one tribe's use of a plant somehow preceded or was ancestral to another tribe's use of the same plant, we rooted our analysis in the uses of plants by a hypothetical tribe that has never used any dye plants: hence all character

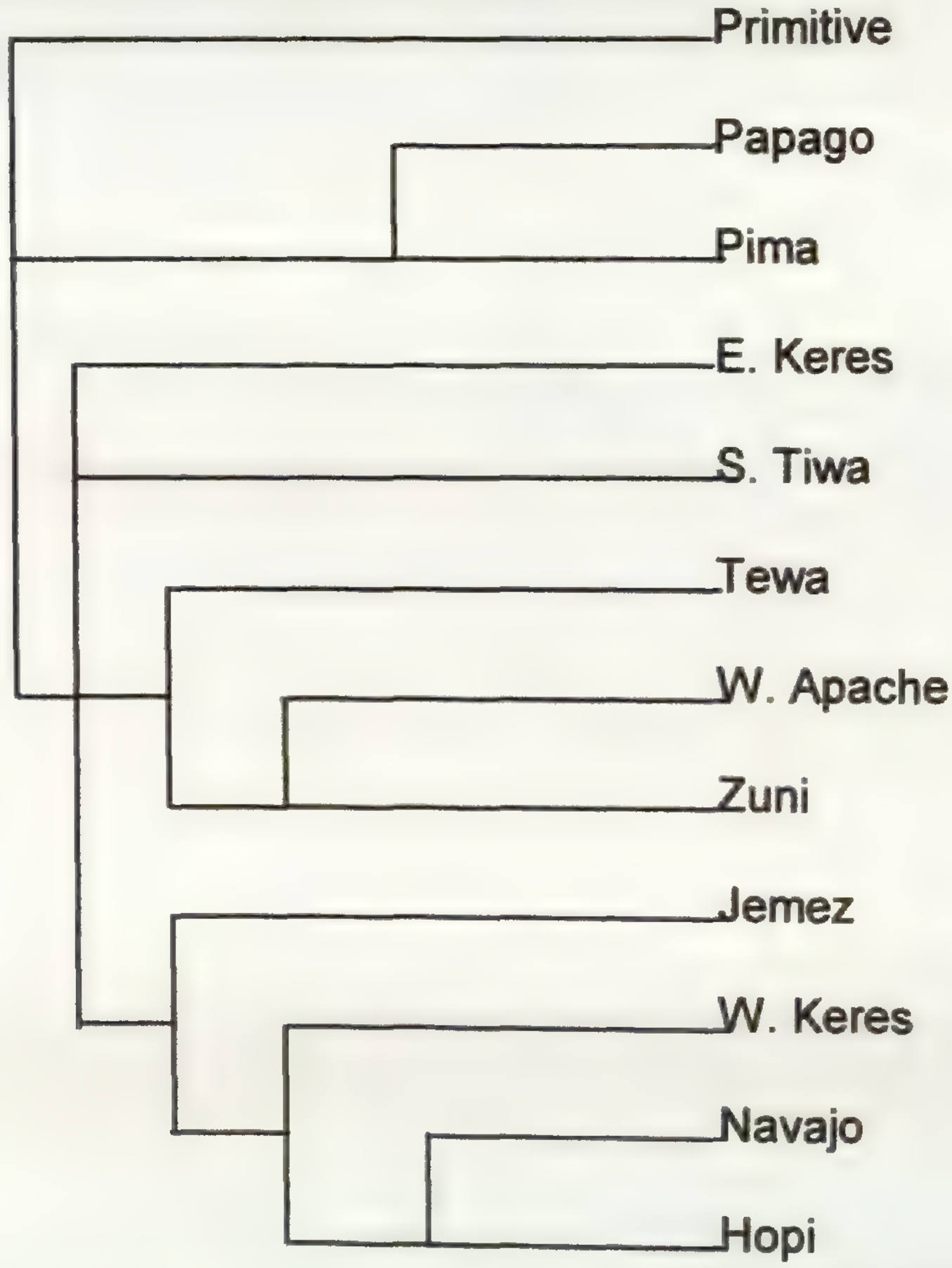

FIGURE 2.— Cladistic relationships of dye plant traditions of southwestern Amerindian tribes; strict consensus tree of unweighted characters, length= 131, consistency index = 0.82; retention index = 0.51

states begin at zero. We note that alternative methods of cladistic analysis that include unrooted networks are available, but such analyses do not change the topology of our resultant trees, and we believe our postulation of a zero-use cultural antecedent to current Amerindian dye uses is, by *reductio ad absurdum* true: if we were to go back far enough in time (at the extreme, the first aboriginal immigrants to North America), we would eventually find a group of people who did not use any North American plants for dyes. This group would be the most "primitive" group as far as dye technology is considered. Our subsequent analysis assumes that knowledge of how to use dye plants is passed from generation to generation rather than being independently recreated *de novo* each generation–the cultural equivalent of recurrent homoplasy in the cladistic sense.

RESULTS

Enumeration of Dye Plant Species.—A total of 108 species, including 103 vascular plants, two fungi and three lichens, have been recorded as sources of dye pigments for wool, cotton, leather, body and pottery paints, and the coloring of food by the 11 tribes (Appendix 1). The 103 vascular plants represent 38 different families. The majority of the dye plant species are used to dye wool. Of these 108 species, the Navajo use 69, the Hopi use 24, the Western Keres use 14, the Tewa and Zuni use 10, the Jemez use eight, the Western Apache use seven, the Papago use six, the Southern Tiwa use four, and the Eastern Keres and Pima both use three species (Figure 1).

Cladistic Analysis.—Our cladistic analysis based on shared cultural innovation (synapomorphies) in use of dye plant species initially resulted in nine trees, each requiring 131 steps, a consistency index of 0.82 and a retention index of 0.51. A strict consensus tree, which presents all features on which these nine trees agree, showed a basal unresolved trichotomy, but we sought to improve the consistency and retention indices by successive character weightings. We then performed two rounds of successive approximations weighting which was analyzed by implicit enumeration, and seven trees of different topologies (Figure 2) were obtained with

TABLE 1.—The 11 most commonly used dye plants and the associated tribes that use those plants.

Plant species	Tribes that use them
Alnus tenuifolia	Jemez, Navajo, S. Tiwa, Tewa, W. Apache, W. Keres, Zuni
Cercocarpus montanus	E. Keres, Jemez, Navajo, S. Tiwa, W. Keres
Chrysothamnus nauseous	Navajo, Tewa, W. Apache, W. Keres, Zuni
Cleome serrulata	E. Keres, Navajo, S. Tiwa, Tewa, Zuni
Pinus edulis	Hopi, Jemez, Navajo, W. Keres
Atriplex canescens	Hopi, Navajo, Tewa
Betula occidentalis	Hopi, Jemez, Tewa
Castilleja integra	Navajo, W. Apache, Zuni
Descurainia pinnata	Hopi, Jemez, Tewa
Psilotrophe tagetina	W. Apache, W. Keres, Zuni
Rhus aromatica	Hopi, Navajo, W. Keres

a higher consistency index of 0.98 and a retention index of 0.90, all with 940 steps. Although the strict consensus tree of the weighted samples reduced resolution from the unweighted analysis by collapsing the original basal trichotomy into a basal hexatomy, all other topological features of the tree remained the same as the unweighted tree (in fact, the tree produced from character weighting, is, topologically, still a subset of the unweighted tree.). We note that the consistency index (but not the retention index) may be an overestimate of the robustness of our analysis since this statistic is sensitive to autapomorphies (characters restricted to one tribe, in our analysis, uniquely derived plant uses not shared with other tribes), in which some traditions we studied, particularly that of the Navajo, abound.

Of the 108 plant species used as characters, only 27 are synapomorphies. This level of autapomorphy which, as mentioned above, does affect the consistency

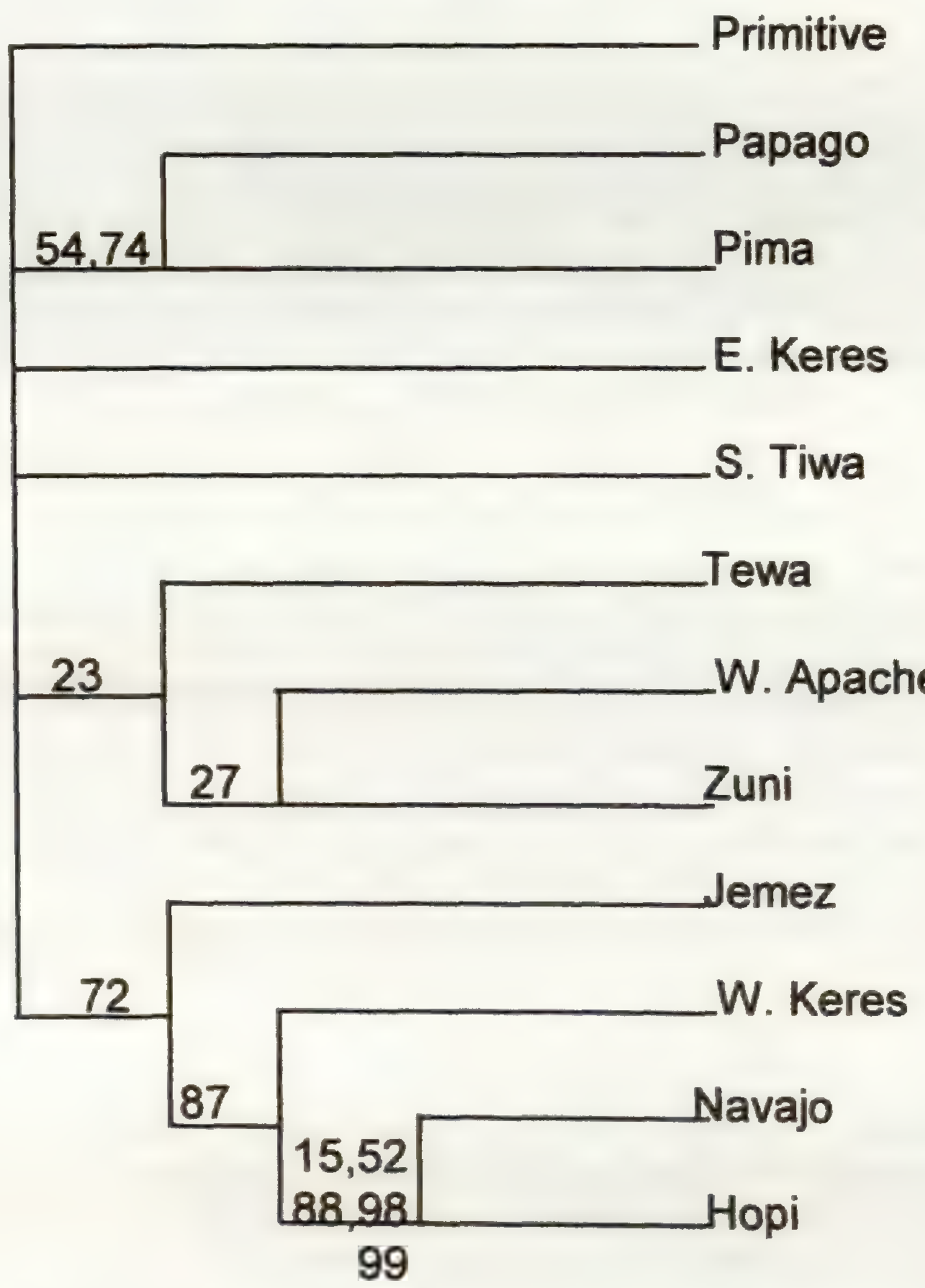

FIGURE 3.—Cladistic relationships of dye plant traditions of southwestern Amerindian tribes; strict consensus tree of weighted characters, with two successive rounds of implict enumeration; length= 940, consistency index = 0.98; retention index = 0.90. The synapomorphies are indicated by a number which refers to specific plant species as identified in Appendix 1.

index. Yet, including all of the data does not affect global parsimony or successive weighting methods, and, of course, leaves the tree morphology unaltered. However, many of the nodes of the consensus tree are supported by a relatively few number of synapomorphies, so it is conceivable that the topology of the consensus tree could change as plant uses from other additional tribes outside of our study area are added to the sample.

A strict consensus tree (Figure 3), which combines the features on which that all of the seven most parsimonious trees agree, shows dye plant use of the Hopi and the Navajo to be more closely related to each other than the use of plants by either tribe is to their sister group, plant used among the Western Keres. Synapomorphies (shared characters or innovation in use of a plant species for dye) linking the Hopi and Navajo include *Carthamus tinctorius* (an introduced species), *Juniperus osteosperma, Rumex hymenosepalus, Thelesperma megapotamicum,* and *Thelesperma subnudum*. Dye use among members of the larger clade consisting of the Navajo, Hopi, and Western Keres was more closely related to dye use among the Jemez than to any of the other tribes considered. The synapomorphy (shared innovation) linking the clade composed of the Navajo, Hopi, and Western Keres is *Rhus aromatica*. Dye use among the clade consisting of the Navajo, Hopi, Western Keres, and Jemez was more closely related to each other than to all other tribes on the basis of *Pinus edulis* as a synapomorphy. The other clades consistently grouped in the strict consensus tree were the Western Apache and Zuni linked by the synapomorphy of *Coreopsis cardaminefolia*. Use of *Chysothamnus nauseosus* link the Western Apache, Zuni, and Tewa, although our analysis indicates an independent origin for the use of this species among the Navajo and Western Keres. A less parsimonious solution is, of course, that the other tribes lost this knowledge. Such homoplasy may disappear from the cladogram as plant used for dyes from more tribes are added to the data set, and, in an adapation of cladistic biogeography, as comparative cladograms for plants used for different purposes (i.e. medicinal, ritual, etc.) are overlaid with dye plant use. The Papago and Pima share two synapomorphies—*Krameria parviflora* and *Prosopis velutina*. However, the pattern of branching cannot be resolved in the strict consensus tree for the Eastern Keres and Southern Tiwa. However, in the unweighted tree they form a sister group to the Papago and Pima.

DISCUSSION

Enumeration of Dye Plant Species.—Certain questions are raised from our study in both the enumeration of plant uses and in the subsequent cladistic analysis. Why do the Navajo use so many unique plants (cultural autapomorphies), especially in comparison to the other tribes? We believe that the importance of dye plants in the Navajo economy, specifically in weaving, creates an incentive for Navajos to use more dye plants. For the Navajo, weaving has been, and continues to be, an important source of income (Hedlund 1992; Roessel 1983). Weaving as a source of commercial income for the Navajo was established by 1900 (Wheat 1979). Indeed, at that time the Navajo rug was the only handwoven good from natives of the Southwest that still had significant trade value (Minge 1979). The Navajo have

been praised for the highest quality of weaving observed among regional indigenous groups. Some have estimated that the Navajos emerged as premier weavers by the 1800's (Mathews 1891; Wheat 1979). The Navajo adopted weaving about 300 years ago and yet they didn't use a great number of dye plants until the beginning of the 20th century (Hedlund 1992). Indeed, one of the earliest recordings of dye plant use among the Navajo only mentions seven dye plants (Mathews 1891). Aniline dyes were also employed during the early part of this century, but by the 1930's there was a resurgence of interest in natural dyes (Reichard 1936), and in today's market a weaver can get a better price for a rug made with vegetal dyes than one that is made with aniline dyes. For these reasons we believe the Navajo have a stronger incentive to use vegetal dyes and to continue experimenting and finding more plants that produce good dyes, even looking outside their own cultural knowledge of dye plant use. This incentive may have also contributed to the Navajo looking to Anglo/Western sources for plant dye information, as found in Amsden's *Navajo Weaving* (1940). Our interviews with different weavers and traders show a general consensus that experimentation with new plants to find new dyes is common today. This is also supported in the literature (Hedlund 1992; Jones 1948). Hence there is an economic motivation for use of plant dyes. This motivation may be a determining factor in the continued use of natural dyes and may contribute to the fact that many weavers today are continually experimenting with new plants and combinations of plants for unique dyes. This economic incentive may be significant in the large difference of dye plants used between the Navajo and other tribes.

Tribal population size could also influence the variation in dye flora sizes among tribes assuming that larger tribes, having more people, had greater collective knowledge about what plants make good dye plants. If this were the case, we would expect larger tribes to use more plants. Today the Navajo tribe is the largest of the tribes studied, but it is difficult to assess and correlate fluctuations in tribal size with fluctuations in dye plant use.

Cladistic Analysis.—Of interest in the cladistic analysis is the absence of symplesiomorphies common to all tribes, i.e., dye plants that all 11 tribes use and were derived from some earlier tradition of use or people not included in our analyses. The most commonly used plant is *Alnus tenuifolia*. Seven of the 11 tribes use this plant. The four tribes that do not use it are the Hopi, Eastern Keres, Papago, and Pima. Table 1 shows the 11 most commonly used plants and which tribes use them.

Does the absence of symplesiomorphies mean that different clades (tribes) independently invented the use of dye plants, or some tribes lost the use of a particular plant, or that each tribe merely utilized those plants that were most common and therefore readily available? Obviously the latter hypothesis cannot be true for every tribe, especially when the use of non-native species is considered. But for those tribes only using a few dye plants, independent development of plant dyes is possible. The absence of symplesiomorphies could indicate that different tribes lost the use of a particular plant as acculturation through the influence of Western culture increased with the movement of more European-Americans into their regions. In the case of *Alnus tenuifolia* we can assume that each of the

seven tribes independently invented the use of this plant, but a more parsimonious hypothesis would be that *Alnus tenuifolia* is actually a symplesiomorphy which was "lost" four separate times by the Eastern Keres, Hopi, Papago and Pima.

As we consider other commonly used plants like *Cercocarpus montanus* or *Cleome serrulata*, the question becomes more problematic. These two plants are used by five of the 11 tribes. Were they each once used by all tribes, thus being a symplesiomorphy? If so, the knowledge would have been lost six times. Or is it more likely that the five tribes independently came to use these two plants? Use and diffusion of plant knowledge of such plants may be difficult to assess. Yet some plants lend themselves to easier consideration. *Chrysothamnus nauseosus* could easily be placed on the cladogram below the Tewa, and use of it could have been lost by both the Jemez and Hopi.

The Navajo have 51 autapomorphies (plants used by only that tribe—a uniquely derived, but unshared, innovation). The rest of the tribes have noticeably fewer autapomorphies and are as follows: Hopi–12, Western Keres–six, Tewa–four, Papago–three, Western Apache and Jemez–two, Pima–one, Eastern Keres, Southern Tiwa and Zuni–zero. The presence of unique cultural uses of dye plants suggests that some indigenous groups are putting more energy into finding dye plants, while others are content to use fewer plants and have less variety in their range of color for dyed materials. The large number of autapomorphies that the Navajo have correlates well with their cultural and economic emphasis on woven rugs as discussed above.

This cladistic analysis provides some hypotheses on the cross-cultural diffusion of dye plant use/knowledge. It seems plausible that the Navajo and Hopi would be closely related in dye plant use because of their geographical proximity to each other and the similarity of the environment in which they live. It is feasible that as the Navajo people migrated into the southwestern region they learned about plant use from their nearest neighbors—the Hopi. Clearly, some knowledge was being shared between tribes—the Navajo learned to weave from the Pueblo people. And through their contact with other southwestern tribes, like the Hopi, it is likely that the Navajo learned about plant use, in this case dye plant use.

The relationship between the Western Apache and Zuni plant dye use is surprising at first, given their distinct language differences. But as one closely examines their environments, both live within the White Mountain range which contains a distinctly different flora from the high plateau deserts where tribes that are culturally more similar live. Thus their shared relationship in dye plant use appears to be a function of their shared environment, rather than a closely shared culture.

The Papago and Pima relationship of plant dye use is no surprise—their tribal regions are much further west and south than the Pueblo tribes and the Navajo/Western Apache. It would be expected that their flora is the most different of all tribes studied based on the ecology of their homeland. Indeed, of all the tribes studied, they have the smallest potential dye flora within their ecological boundaries. Also, the Papago and Pima come from the Uto-Aztecan language stock, as do the Hopi, but the Hopi live in much closer proximity to the Puebloan tribes and share many cultural traditions with them. The Papago and Pima are more unique in their cultural background and it would be expected that they would emerge as more closely related to each other in dye plant use than to other tribes.

CONCLUSIONS

This comparative study shows a wide range of plants used by Native Americans for dye purposes. Such variation suggests several scenarios in the evolution of dye plant use: (1) those tribes that place a greater emphasis on dyeing, due to factors such as the economics of dyed materials or cultural significance, may have actively sought to find plants that yield pigments and thus increased their overall dye flora, (2) some tribes may have lost dye plant knowledge through acculturation and assimilation into the Western culture, (3) some tribes could have independently invented the use of certain plants for dyes, and (4) larger tribes may have retained more information about their tribal dye flora whereas dye plant use may decrease as tribal size decreases over time. Most likely, a combination of these factors account for the variation seen among the eleven tribes considered in this study.

The fact that some tribes use very few plants is as telling as those tribes that use many dye plants. The cultural importance of weaving, dyeing and painting varies between tribes. We might assume that those tribes that place a higher significance on such activities will have a larger dye flora. And conversely, those tribes who use few plants may place a lesser value on weaving and dyeing. By comparing plant use in other areas, we could piece together potential cultural values for each tribe, based on size of flora used for different means (medicinal, agricultural, ceremonial/ritual, building, etc.). Dye use is merely one piece of a larger picture that helps us understand not only cultural uses of plants, but those things that are important in different cultures as well.

Cladistic analyses can generate hypotheses of cross-cultural diffusion of dye plant use hat might not be readily apparent if one were to limit cultural comparisons to overall similarities. Again, we reiterate that this analysis does not suggest overall cultural relationships between the eleven tribes studied since we considered only one small aspect of material culture: dye plant use. Our analysis does, however, suggest hypotheses on how dye plant knowledge may have spread between the different tribes and which tribes were sharing ethnobotanical knowledge. We find a strong ethnobotanical link between the Hopi and Navajo, the Zuni and Western Apache, and the Papago and Pima. These different indigenous groups could have been sharing information about dye plants with each other, both potentially enlarging their own dye flora from the others' ethnobotanical knowledge. The exact history of use and knowledge will not be known, but hypothetical situations can be generated by cladistic studies which are amenable to falsification by archaeological or ethnohistorical data.

Further cladistic analyses on different ethnobotanical uses—such as medicinal and agricultural plants, plants used for clothing, shelter and tools, and plants with ritual significance—could be overlaid in the same way that vicariate biogeographers overlay different plant and animal phylogenies to discover relationships between diverse geographical areas. Such iterative cladistic analyses (towards which our study is only a small step) could provide fascinating clues and trends into ethnobotanical cross-cultural interactions. By overlaying such analyses we might generate hypotheses of cultural interactions that may not be readily apparent otherwise.

As indigenous knowledge systems throughout the world continue to disappear, it is important to understand how ethnobotanical knowledge diffuses across cultural boundaries. Using plants as shared innovations and comparing tribal use of plant species using cladistic analyses may provide one key to understanding such knowledge transfer. It is a simple technique that can clarify relationships between indigenous cultures and elucidate the exchange of knowledge and technologies. Cladistic analyses may also render insights on plant technologies that were independently invented versus those that were exchanged across cultural boundaries.

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[1]To whom reprint requests should be addressed.

APPENDIX 1.—Plants used for dye purposes and corresponding tribes that use(d) them. Plants are used to dye wool, unless otherwise indicated. Numbers in each box refer to reference(s) that indicated tribal use of each plant.*

	Eastern Keres	Hopi	Jemez (Towa)	Navajo	Papago	Pima	Southern Tiwa	Tewa	Western Apache	Western Keres	Zuni
ASTERACEAE 1. *Actinea gaillardia*				37							
2. *Actinea leptoclada*				37							
SCROPHULARIACEAE 3. *Adenostegia wrightii*		34 body paint									
BETULACEAE 4. *Alnus tenuifolia*			6 leather	1,7,9,12, 15,19,20 22,24,28 32,37			16	7,11, 25	7,23	7,30 leathe r	7,23 leather
AMARANTHACEAE 5. *Amaranthus cruentus*		10,31, 34 wafer bread									29 wafer bread
6. *Amaranthus palmeri*		13,14 wafer bread									7 wafer bread
ASTERACEAE 7. *Artemisia tridentata*				37							
GRAMINEAE 8. *Arundo donax*					4,7						
CHENOPODIACEAE 9. *Atriplex canescens*		7,13, 14 wafer bread		18,32, 37				7,25			
10.*Atriplex rosea*				18							
BERBERIDACEAE 11.*Berberis fremontii*				20							7,29
12.*Berberis repens*				20,37							8
BETULACEAE 13.*Betula occidentalis*		7,14 leather	6 leather					14 leather			
ASTERACEAE 14.*Carduus occidentalis*				1							
15.*Carthamus tinctorius* (introduced)		7,10,13, 14,32,34 wafer bread		7							
SCROPHULARIACEAE 16.*Castilleja integra*				37					23		7,29 leather
17.*Castilleja linariaefolia*		34									

	Eastern Keres	Hopi	Jemez (Towa)	Navajo	Papago	Pima	Southern Tiwa	Tewa	Western Apache	Western Keres	Zuni
LINACEAE 18.*Cathartolinum puberulum*										7,30 paint	
ULMACEAE 19.*Celtis reticulata*				7,9							
ROSACEAE 20.*Cercocarpus breviflorus*		5,34									
21.*Cercocarpus montanus*	33		6 leather	1,7,9,12 15,18,19 20,22,24 28,32,37			16 leather			30 leathe r	
ASTERACEAE 22.*Chrysothamnus latisquamena*				7,37							
23.*Chrysothamnus nauseosus*				1,7,9,12, 15,18,19 20,32,37				11	7,23	7,25	7,29
24.*Chrysothamnus parryi*		10 body paint									
25.*Chrysothamnus viscidiflorus*				9 plant materia							
CAPPARACEAE 26.*Cleome serrulata*	33			20,37			16,33	7,11, 25,35 paint			7,29
ASTERACEAE 27.*Coreopsis cardaminefolia*									7,23		7,29
ROSACEAE 28.*Cowania mexicana*				7,9,20, 24,37							
CUCURBITACEAE 29.*Cucumis melo* (introduced)		34 body paint									
30.*Cucurbita foetidissima*									7,23 sand paint		
CHENOPODIACEAE 31.*Cycloloma atriplicifolium*		34									
RANUNCULACEAE 32.*Delphinium scaposum*				24,37							
CRUCIFERAE 33.*Descurainia pinnata*		7,10, 34	B paint					7,25 genus only			

	Eastern Keres	Hopi	Jemez (Towa)	Navajo	Papago	Pima	Southern Tiwa	Tewa	Western Apache	Western Keres	Zuni
ASTERACEAE 34.*Encelia farinosa*					4,7						
35.*Endothia singularis* (fungus)				17							
GNETACEAE 36.*Ephedra trifurca*				9,12							
37.*Ephedra viridis*				37							
CRUCIFERAE 38.*Erysimum capitatum*										8,30	
OLEACEAE 39.*Forestiera neomexicana*			6 body paint	37							
ERICACEAE 40.*Gaultheria humifusa*				7,9							
ASTERACEAE 41.*Gutierrezia sarothrae*				18							
42.*Helenium hoopesii*				12,24, 37							
43.*Helianthus annuus*				9							
44.*Helianthus petiolaris*		7,13, 14									
SAXIFRAGACEAE 45.*Heuchera bracteata*				7,9,24							
ASTERACEAE 46.*Hymenoxys metcalfei*				7,37							
IRIDACEAE 47.*Iris missouriensis*				20							
JUGLANDACEAE 48.*Juglans major*				7,9,37							
49.*Juglans regia* (introduced)				9							
CUPRESSACEAE 50.*Juniperus deppeana*				18							

	Eastern Keres	Hopi	Jemez (Towa)	Navajo	Papago	Pima	Southern Tiwa	Tewa	Western Apache	Western Keres	Zuni
51.*Juniperus monosperma*				1,7,9,22, 24,28,32 37						30 leathe r	
52.*Juniperus osteosperma*		34 body paint		9,28							
53.*Juniperus scopulorum*										30	
FABACEAE 54.*Krameria parvifolia*					4,7 cotton, leather	7,26 leather					
ZYGOPHYLLACEAE 55.*Larrea tridentata*	7				4,7 tattoo						
56.*Letharia vulpina* (lichen)									7,21		
FABACEAE 57.*Lupinus kingii*				37							
58.*Medicago sativa* (cultivated)				9							
NYCTAGINACEAE 59.*Mirabilis multiflora*				20							
LILIACEAE 60.*Nolina microcarpa*				16							
CACTACEAE 61.*Opuntia engelmannii*										30 paint	
62.*Opuntia phaecantha*				20							
63.*Opuntia polycantha*				9,24, 37							
64.*Parmelia molliuscula* (lichen)				1,9,37							
FABACEAE 65.*Parryella filifolia*		13,14 wafer bread									
AMPELIDACEAE 66.*Parthenocissus vitacea*			6 body paint								
ASTERACEAE 67.*Pectis angustifolia*		5									
68.*Petradoria pumila*				9							

	Eastern Keres	Hopi	Jemez (Towa)	Navajo	Papago	Pima	Southern Tiwa	Tewa	Western Apache	Western Keres	Zuni
FABACEAE 69.*Phaseolus vulgaris* (cultivated)		3,5,34									
LORANTHACEAE 70.*Phoradendron juniperinum*				9,23							
PINACEAE 71.*Picea pungens*				9							
72.*Pinus edulis*		34	6	1,9,15, 19,20, 22,32, 37						30	
CAPPARACEAE 73.*Polanisia trachysperma*								8,25			
FABACEAE 74.*Prosopis velutina*					7,10 paint	2,7 paint, hair dye					
ROSACEAE 75.*Prunus americana*				7,9,37			16 leather				
76.*Prunus emarginata*				9							
77.*Prunus melanocarpa*				37							
78.*Prunus persica* (introduced)				9							
79.*Prunus virginiana*				20							
UMBELLIFERAE 80.*Pseudocymopterus montanus*				37							
ASTERACEAE 81.*Psilotrophe tagetina*									23	8,30	7,8,29
MONOTROPACEAE 82.*Pterospora andromedea*				37							
PYROLACEAE 83.*Pyrola chlorantha*				36 paint							
ROSACEAE 84.*Pyrus malus*				9							
FAGACEAE 85.*Quercus gambelii*				20,37							

	Eastern Keres	Hopi	Jemez (Towa)	Navajo	Papago	Pima	Southern Tiwa	Tewa	Western Apache	Western Keres	Zuni
86.*Quercus pungens*				7,36							
ANACARDIACEAE 87.*Rhus aromatica*		5,33		1,7,9,15, 18,19,22 24,27, 31,35,36						7	
POLYGONACEAE 88.*Rumex hymenosepalus*		5,8,34		1,7,9,12, 15,18,19 24,32,37							
SALICACEAE 89.*Salix irrorata*								7,25 body paint			
CHENOPODIACEAE 90.*Salsola kali*				37							
91.*Sacrobatus vermiculatus*				20							
ASTERACEAE 92.*Senecio douglasii*				24							
MALVACEAE 93.*Sphaeralcea angustifolia*								7 body paint			
CRUCIFERAE 94.*Stanleyella wrightii*								7,25			
ASTERACEAE 95.*Tagetes micrantha*				9,37							
96.*Taraxacum officinale*					4 paint						
97.*Tetradymia canescens*				18							
98.*Thelesperma megapotamicum*		5,7,10, 13,14, 34		18,32, 37							
99.*Thelesperma subnudum*		5,34		9							
TYPHACEAE 100.*Typha angustifolia*						7					
101.*Ustilago zeae* (fungus)		34 body paint									
ERICACEAE 102.*Vaccinium humifusum*				9							

	Eastern Keres	Hopi	Jemez (Towa)	Navajo	Papago	Pima	Southern Tiwa	Tewa	Western Apache	Western Keres	Zuni
AMPELIDACEAE 103.*Vitis arizonica*			6 body paint								
ASTERACEAE 104.*Xanthium commune*										30 body paint	
105.*Xanthoparmelia conspersa* (lichen)				18,32							
LILIACEAE 106.*Yucca glauca*				18,32							
GRAMINEAE 107.*Zea mays* (cultivated)		5,34									
ASTERACEAE 108.*Zinnia grandiflora*										30	

* References of specific citations of each plant used among different tribes. See literature cited for full citation.

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	Primitive	E. Keres	Hopi	Jemez	Navajo	Papago	Pima	S. Tiwa	Tewa	W. Apache	W. Keres	Zuni	
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	Primitive	E. Keres	Hopi	Jemez	Navajo	Papago	Pima	S. Tiwa	Tewa	W. Apache	W. Keres	Zuni	
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APPENDIX 2.—Data matrix for cladistic analysis. Characters are represented by individual plant species as numbered in Appendix 1. A blank cell denotes plant not used by tribe, a "1" denotes plant used.

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